Comparative Environmental and Planning Law Relating to Light Pollution Control in England and Other Jurisdictions

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A thesis submitted in partial fulfilment of the requirements of De Montfort University for the Degree of Doctor of Philosophy

School of Law

De Montfort University

September 2015

Abstract

The 24-hour day/night cycle naturally helps to maintain balance and stability within a nocturnal ecosystem. While the rhythms of the natural light-dark cycle of day and night are able maintain a stable balance with ecological and human-made activities in relation to the nature of lighting and darkness, light pollution still significantly reduces average human well-being, impacts on the visibility of faint night sky objects during the night with the naked eye and telescope, and damages the night environment. It can be defined as "*every form of artificial light in the wrong place at the wrong time which creates a sky glow, glare, nuisance, and other relevant causes of environmental degradation including some properties of artificial light which emit non-environmentally friendly or inappropriate light.*"

Light pollution can reduce human health, interfere with the nocturnal and/or dark-sky environment, reduce transportation safety and waste lighting energy consumption. Therefore, hard laws and soft laws from international and national jurisdictions established a duty on local authorities to manage outdoor lights and control all key elements of light pollution so as to ensure that people are not exposed to risks to the night environment. These also include environmental risks arising from a sky glow when measuring the non-environmentally atmospheric smog that hangs over urban areas at night where the level of exterior lighting from outdoor light sources is relatively high. However, English law does not contain stage processes and responsibilities for local authorities to deal with all aspects of outdoor light pollution. It also does not contain powers concerning the use of certain measurable degrees of non-environmentally friendly light metric, together with powers for the Government to approve a single framework for the minimisation of sky glow in public atmospheric areas at night.

The main purpose of this study is to use comparative law studies to better understand the strengths and weaknesses of light pollution laws in different jurisdictions where adopted legislation has been designed to limit light pollution from outdoor light fixtures and design, and to improve national or local light pollution regulatory frameworks by

providing better outdoor lighting practices through making valuable contributions to a comparison of international, European, national and local light pollution laws and to the improvement of regulatory measures in English legal system. It also proposes to do so by illustrating key differences between England and other jurisdictions and examining a set of necessary or proportional regulatory standards to combat light pollution.

This research's review of the jurisdictions and the legal systems available for both light pollution control and sustainable lighting practices has highlighted the recent evidence of such influence of hard and soft law on legislation in selected countries. When comparative law on different jurisdictions is discussed, the influence of a comparative approach in each national or municipal light pollution law is, at most, one of finding inspiration in the procedure of establishing a number of necessary steps to reforming the English law of light pollution control in favour of a better solution.

Taking legal action to reduce the effects of non-environmentally friendly or unnecessary lights at night provides an excellent opportunity to deliver further benefits to both environmental lighting practices and energy efficiency. This research also highlights the key legal aspects concerning light pollution and outlines the ways in which regulators and policy makers can make the most of the interconnections between regulatory measures to address key elements of outdoor light pollution, such as sky glow, glare and intrusive light. It is intended to outline a wider vision for how English law can prevent all key elements of light pollution.

This research also comparatively examines why England should be committed to ensuring that the English regulatory measures compare favourably with the global and regional light pollution control standards in the highest performing jurisdictions, and establishes stringent legal requirements for light pollution control which measure up to the highest standards set internationally. In the final Chapter we present useful recommendations which highlight instances in which England should be able to promote the application of necessary principles and stage processes through comparative effectiveness for outdoor lighting practices by applying international, regional and national criteria for different forms of outdoor lighting practices.

Acknowledgements

I would like to take this opportunity to thank you for your generosity in funding the Chiang Mai University (CMU) Faculty of Law's Academic Career Development Scheme Scholarship 2014/2015 that I received this year as part of my financial research support package. I am writing to thank all CMU academic and support staff for their generous support towards my PhD research. After graduation, I will seek employment at the CMU Faculty of Law with the hope of inspiring all CMU law students to achieve their legal education.

I actually know that behind every academic or athlete are their supervisors or coaches. I would like to thank my PhD supervisors and athletic coaches, Martin Morgan-Taylor, Dr Neil Brown, Professor Gavin Dingwall and Claire Shea-Simonds for all their help and guidance throughout the law research study, as well as athletic training, and to thank Bob Mizon, M.B.E for all his faithful Campaign For Dark Skies (CfDS)'s financial support and encouragement in my light pollution research pursuits, without whose continued assistance and encouragement this thesis would never have been completed.

Sincere gratitude also goes out to all my family, Dr Conrad Nyamutata, postgraduate research colleagues, runDMU, Leicester Runners, Braunstone parkrun and West End Runners' friends for their encouragement and support.

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Chapter 1: Introduction

Light pollution damages human health and the night environment. It is caused by economic activities such as transportation, transport, energy, commerce, safety, security, sports and recreation, as well as some cultural activities like outdoor Christmas lighting decoration. It still significantly reduces average human well-being, impacts on the visibility of faint night sky objects during the night with the naked eye and telescope, and damages the nocturnal environment. The key purpose of this chapter is to introduce a comparative law methodology to better understand a statement of that tells all relevant light stakeholders (i.e. manufacturers, producers, service providers, suppliers, wholesalers, distributors and retailers) how comparative law will be used as recommendations for the English law, how this research will identify many possible approaches that may be able to underpin legal issues regarding non-environmentally friendly lights, and why this research makes itself clear that England should reform and enforce the regulatory requirements (i.e. mechanisms, instruments, and metrics of light pollution control) to make a commitment to combat outdoor light pollution by reducing key elements of light pollution and standardising exterior lighting practices.

In order to address research questions, assumptions and methodologies preliminary by providing key problems of light pollution law in England to all relevant light stakeholders more information regarding strengths and weaknesses of the current English law, this chapter will start by analysing the current *Clean Neighbourhoods Act 2005* from a number of previous light pollution cases and statutory law perspectives, focusing in particular on the non-environmentally friendly light paradigm that has emerged since the 1970s.

1.1 The issue

The key objective of this subheading is to highlight a number of legal problems with existing English regulatory frameworks. It will require the legislators, policy makers and other relevant light industrial stakeholders to consider legal matters, and to act upon them when they have been identified. Additionally, introduction to modern light pollution problems can raise critical questions about what should happen to the light pollution law reform in the future. The best option was thought to be improving the

current law, particularly the statutory law. At present, the current *Clean Neighbourhoods and Environment Act 2005* as the main English domestic legal instrument against light pollution, lacks a range of coherent light pollution provisions. In considering whether a regulatory tool is an appropriate mechanism, there is a need to extend all aspects of light pollution control for outdoor lighting practices. As a result, the question of how environmental protection should work from a legal perspective in the context of light pollution control largely remains unanswered. Again, the main aim of this subheading is to analyse the strengths and weaknesses of the current English law and highlight legal issues to be considered further.

1.1.1 Current English statutory nuisance does not launch to close legal loopholes exploited by all elements of outdoor light pollution

Before the implementation of the *Clean Neighbourhoods and Environment Act 2005*, there were few cases on artificial light nuisance, for example in *District Angling Association v Stonehaven Recreation Ground Trustees* [1997] 60 SPEL 36 the artificial light from a tennis club was allowed to illuminate or pollute neighbouring areas not intended to be lit. In this case, artificial nuisance by lighting interference was probably best described as misdirected or inappropriate illumination of sports and recreation facilities. The intrusive light from the sports facilities was poorly directed lights shining onto neighbouring property affecting the neighbours' right to enjoy their property. The former nuisance in English common law system protected landowners and tenants from interference with misdirected or inappropriate illumination.[1]

A new section added to the definitions of Statutory Nuisances within the *Clean Neighbourhoods and Environment Act 2005*, as the current statutory nuisance from artificial light may be a step to encourage and promote the reduction of light pollution from sources of complaint about artificial light nuisance, including artificial lights emitted from premises so as to be prejudicial to health or a nuisance, such as domestic security lights, commercial security lights, exterior lighting of buildings and landscapes,

[1] Department for Environment, *Food and Rural Affairs, An Investigation into Artificial Light Nuisance Complaints and Associated Guidance Final Report*, Department for Environment, Food and Rural Affairs, 2007, p 13.

light show and art, sky beams, streetlights and licensed premises, such urban places gain the night environment protection instruments required for effective environmental and planning law regimes.[2] However, it does not cover light emitted from premises used for transport purposes, or other premises where high levels of light are required for safety or security reasons, i.e.: airports, public service vehicle operating centres, harbours, vehicle, depots, railway premises, lighthouses, tramway premises, prisons, bus stations and related businesses and premises occupied by military installations. Therefore, artificial light emitted in terms of premises used for public service and transportation are some of the light pollution problems that can particularly be experienced.

In English law, there is no fixed standard which constitutes a statutory nuisance. Individual light nuisance circumstances differ and each case has to be judged on its own merits. Nevertheless this leads us to the question of the effective standards of a better light pollution solution in England. Light nuisance legislation in England does not provide clear technical guidance on lighting itself. As many effects of light pollution have been identified, this strongly suggests that a preventative approach to light pollution, including lighting design and fixtures, should be advocated by the Government, within the context of environmental and planning legislation.

Furthermore, to fulfil the legal criteria meaning of word in the *Environmental Protection Act 1990*, it seems that artificial light '*nuisance*' is traditionally narrower than '*annoyance*' in common law.[3] Artificial light nuisance as a statutory nuisance is essentially about public and private health, and it must be intrusive. A statutory defence of '*best practicable means*' is available merely for artificial light emitted from industrial, trade or business premises; and artificial light emitted by lights used for the sole purpose only of illuminating an outdoor relevant sports facility.[4] Section 102 of the *Clean Neighbourhoods and Environment Act 2005* also creates a specific form of artificial light nuisance '*artificial light emitted from premises so as to be prejudicial to*

[2] Department for Environment, Food and Rural Affairs, *Statutory Nuisance from Insects and Artificial Light, Guidance on Sections 101 to 103 of the Clean Neighbourhoods and Environment Act 2005*, Department for Environment, Food and Rural Affairs, 2005, p 10.
[3] See *Davies v Dennis & Ors* [2009] EWCA Civ 1081
[4] Sport England, *Artificial Sports Lighting Updated guidance for 2012*, Sport England, 2012, p 28.

health or a nuisance'.[5] Notwithstanding, artificial light could be emitted from premises so as to be prejudicial to the urban dark sky, night environment and ecological system by poorly designed and installed lighting.

The current legal framework relates to artificial light emitted from premises so as to be prejudicial to health or a nuisance. It does not however cover artificial light emitted from the purposes of safety or security reasons. The light premises as mentioned above are exempt as they are either light premises used for purposes of transportation or other light premises where high levels of light are required for the purpose of safety and security. Therefore, for light to be considered to be a statutory nuisance, it must be prejudicial to health or be considered a statutory light nuisance. There are, however, several exemptions where light from certain sources cannot be considered a nuisance. Outdoor lights from transportation, safety, and security premises can emit any artificial light that is allowed to illuminate areas not intended to be lit, but the *Clean Neighbourhoods and Environment Act 2005* excludes some sources of light pollution from outdoor lighting for safety and security reasons, for example, airports, goods vehicle depots, lighthouses, railway and bus stations, defence premises and prisons. To help minimise light disturbance from transportation, safety, and security sites, the power to restrict the lighting times, light direction, and level of light at which outdoor light works take place may set the balance of the public interest in maintaining the exception for transportation, safety, and security reasons as well as abating nuisance from these exemption premises as mentioned in the next chapter.

It seems that the requirements of the *Clean Neighbourhoods and Environment Act 2005* cannot apply to all nuisance circumstances. Again, the Act does not address the lighting standardisation of all outdoor illuminating devices that should be installed to conform with the provisions for controlling nuisance from light emanating from any human-made device. Although all lighting can be designed so that the point source of light or any reflective surface of the light fixture should not directly, indirectly, or cumulatively illuminate the neighbours' areas, English law does not contain environmentally friendly

[5] Temple Group, *Assessment of the Problem of Light Pollution from Security and Decorative Light Published Guidance/Standards on Obtrusive Light*, Temple Group, 2006, p 10.

illuminating techniques for all outdoor lighting control. Therefore, there is a conflict between the general provisional requirements of a nuisance and a specific provisional requirement of public safety or security lighting reasons. The light emitted from premises used for purposes of transportation or other light premises where high levels of light are required for purposes of public safety and security reasons can be caused when excessive or obtrusive lighting is inappropriately sited, thereby intruding into neighbouring properties and the night environment.

1.1.2 Urban areas suffer from a lack of official plans concerning specific sectors that could deter key forms of light pollution from the unplanned urban development

Lighting schemes for planning developments may have planning conditions determined as part of the planning application and permission under the *Town & Country Planning Act 1990*, to ensure that no light pollution is created by light premises.[6] Albeit such pollution concern, through any lighting conditions of planning application and permission being breached, the local planning authorities could take legal enforcement, for example, planning permission of existing lighting materials and planning permission of proposed lighting materials. The clarification of planning application forms generally contributes to the achievement of the following planning development objectives, nevertheless there is no artificial lighting criterion in considering applications for planning permission for urban development, for example, outdoor lighting practice related to planning development.

Furthermore, in order to fulfil the objective of helping achieve planning law enforcement, the Government sets out a specific planning policy for pollution control to lead their local planning decisions on applications. The National Planning Policy Framework, as a specific planning policy for helping achieve sustainable development, particularly fulfils the statutory status of the planning development as the point for decision-making guidance. Paragraph 125 states that planning authorities should take account of, in preparing Local Plan policies, '*By encouraging good design, planning*

[6] Institution of Lighting Engineers, *Guidance Notes for the Reduction of Light Pollution, Institution of Lighting Engineers*, Institution of Lighting Engineers, 2000, pp 1-4.

policies and decisions should limit the impact of light pollution from artificial light on local amenity, intrinsically dark landscapes and nature conservation. ...'[7] Even though the National Planning Policy Framework sets out the Government's planning policies and principles on the most important aspects of development planning, there is no specific policies regarding lighting practices within national planning guidance.

So that we may ensure the protection of the right of every person of present and future generations to live in an environment adequate to their health and well being, the Government and local authorities should clarify the right to live without light pollution impacts in accordance with the provisions of the English legislation. Carrying out development without long term planning might cause environmental problems. There is no legal obligation upon local authorities to carry out monitoring of the local dark-sky environment, or monitoring requirements with respect to both environmentally friendly outdoor lighting as well as energy-efficient outdoor lighting. This also means that local authorities have failed to enforce all elements of light pollution. It is possible for the local authorities to make the conditions and modalities of spatial planning and development for light pollution control. If lighting installation has been erected without planning approval or permission, it is possible for the local authorities to require it to be reinstalled. Additionally, local outdoor lights could be subject to the global requirements for light pollution control. For example, outdoor lights should be shielded to prevent any light to be directed at oncoming urban transportation in such excessive brilliance as to impair the visibility of any road users and to be directed upward to the atmospheric areas.

1.1.3 Effective leadership and coordination of parties with environmental pollution responsibilities is not focused on what is necessary to support the night environment quality improvements to benefit public health and to manage harmful light pollution risks

Light pollution has increased during the process of urbanisation because proliferation of artificial lighting usage generally contributes to the rapid growth of urban planning and

[7] Department for Communities and Local Government, *National Planning Policy Framework*, Department for Communities and Local Government, 2012, p 29.

public transportation. The Government, local authorities and some relevant stakeholders were required by the environmental and planning rules to approach environmental risk management in various processes whereby the risks of pollutions and other environmental harms still exist. However, the Government and local authorities have not coordinated environmental risk control practices in intrinsically dark-sky landscapes as well as district brightness areas, including the nocturnal wildlife conservation areas, and they have not taken the opportunity for all relevant light stakeholders (i.e. manufacturers, producers, service providers, suppliers, wholesalers, distributors and retailers) to impose environmental and planning conditions related to outdoor lighting at night that would increase the harmful risk in both urban and rural areas. Although many lighting governing bodies highlight that England could be affected by non-environmentally friendly or inappropriate lighting at night, they have not successfully required the Government to adopt specific regulatory frameworks, which requires local environmental and planning authorities to make a preliminary assessment of light pollution from all environmental zones for outdoor lighting control (i.e. intrinsically dark landscapes and district brightness areas), and then to identify urban and rural areas at potential risk of light pollution through undertaking a preliminary light pollution risk assessment, mapping the environmental zones for outdoor lighting control within their development plans as well as each producing local outdoor lighting plans.

1.1.4 Local government and other relevant stakeholders are unclear on their legal dark-sky preservation duties and responsibilities and what they can do to help improve dark-sky quality and the night environment

The English legal system does not set regulatory provision as an important tool in recognising important astronomical concepts, such as the concepts of astronomical dark-sky areas (i.e. local stargazing locations and national dark-sky parks). It is important in providing a set of rules with certain healthy dark-sky zoning for minimising outdoor light pollution at night in English dark-sky parks because light pollution can make the sky much brighter than the natural dark sky at night and astronomers may not normally observe or view astronomical phenomenon and sky objects in a bright atmosphere.

1.1.5 To realise the aims of improving the night environment in England according to light pollution awareness, a single legal definition and a number of new methods of environmental light pollution control are needed in the English legal system

England failed to provide adequate control measures for all aspects of light pollution although England increased use of lighting has resulted in environmental and human well-being problems. The requirements of current provisions and the previous precedent of case decisions by the English court do not cover several elements of light pollution. Many of the light pollution issues by this research concern the underpinnings of environmental and planning law. In the absence of the English theoretical approach of light pollution control within which the common law system takes place, the scheme of theory in environmental and planning law applies for protecting or improving the night environment and business' energy usage when using outdoor lighting. There are many legal theories of environmental and planning law, including the scientific basis of illuminating engineering and architectural lighting design. Each theory offers a regulatory approach to light pollution control. On the other hand, several foreign jurisdictions, for example, Japan, France, Italy, Slovenia, U.S., Chile, Canada and Spain, have adopted new lighting methods designed to limit light pollution from public and private premises. Reducing the amount of unnecessary or inappropriate lighting at night visible from public and private premises is the first step that other jurisdictions have made to reduce light pollution through modern methods suitable for managing sustainable outdoor lights and controlling non-environmentally friendly outdoor lighting. Many jurisdictions have passed light pollution frameworks that require their people to minimise any upward waste light by the application of a suitable light direction and level of brightness.

There are numerous appropriate illuminating engineering methods for outdoor light pollution control, for example, lighting efficiency and shielding requirements. These deal with the use of lights and night environment protection. However, there is no single best legal definition to achieve effective illuminating engineering efforts for light pollution control of outdoor light sources because there are numerous appropriate applications and equipment technologies. If light pollution is not legally defined under

the statutory law as an alteration of the night environment to its detriment or degradation, which involves man-made outdoor brightness, particularly from outdoor lighting in urban areas, than the Government and its environmental authorities do not have specific enforcement powers. In addition, interdisciplinary approaches for man-made light pollution control may be unofficially used, but no regulatory characteristics, legal context, measurable features and certain stage processes to control the sources of non-environmentally friendly lighting emission can occur without conforming to the appropriate requirements. A single legal definition of light pollution will provide the key legal contexts for use by all involved in night environmental protection planning at national and local levels. For example, a single legal definition of light pollution allows us to clearly understand the vulnerable elements and environmental impacts of light pollution, including people, property, dark-sky heritage and the night environment at risk. It also shapes or set out objectives for outdoor light pollution across each national and local area (i.e. lights should be turned off when not in use in the local dark-sky conservation areas).

So, the purpose of this research is to consider the numerous regulatory approaches used in light pollution control. The goals of this research are to highlight several important issues of all aspects of light pollution and discuss legal approaches to comparative environmental and planning law. The comparative legal study in particular has potential to engage statutory law reform in aspects of light pollution and to develop interdisciplinary environmental and planning law. This research explores the questions concerning the use of current provision in light pollution control which exist in the English jurisdiction, how these can be gain, and if it is consequently possible to compare between the English jurisdiction and other jurisdictions in order to analyse legal issues and obstacles. This research also recognises the constraints and limitations of each approach in addressing specific environmental and planning problems associated with aspects of light pollution.

As legal issues of light pollution in England have been addressed above, also in the case of current English environmental and planning legislation this research provided all relevant light stakeholders with the opportunity to evaluate previous legal problems that

are specific to suit their academic goals and professional environmentally friendly lighting aims. As the debate of the key aspects of light pollution, brought by the context of light pollution in the next section will demonstrate, this chapter also guides all relevant light stakeholders to deal effectively with light pollution problems on questions of public environmental interest, and to gain a comprehensive understanding of the different contexts of light pollution in a wide array of subjects, through numerous references to explain the main general definitions of light pollution.

1.2 Light pollution definition

To provide fundamental information about light pollution available to help supervisors, examiners, readers and all relevant stakeholders whose purpose it is to deal with legal light pollution problems, this Chapter will also briefly explain general light pollution definitions what causes astronomical and nocturnal damage and that humans, species and habitats, are subject to 24-hour day/night cycle loss through explanation of general light pollution definitions. Giving an indication of general definitions of light pollution can provide an excellent opportunity to deliver further academic benefits to both previous light pollution debates in this field and context to this legal research. Both arise from very similar light pollution awareness and will therefore benefit from previous academic awareness; so the combined awareness is usually better, when this Chapter explain them together, rather than considering them isolation.

As a starting point, as this subheading is going to give a way of delivering further academic benefit, add meaningful discussion relating to the general definitions of light pollution. Such debate of working definitions of light pollution, as referred to below, would may a mean to form a single legal definition of light pollution as mentioned in Chapter 4 and to ensure that supervisors, examiners, readers and all relevant stakeholders are able to understand the intentions that contribute to the ongoing debate on main causes and key elements of light pollution, as mentioned in Chapters 2 and 3.

1.2.1 Introduction to light pollution

Visible light can be defined as electromagnetic radiant energy usually having a wavelength in the region 400-700 nanometres, this range being defined by what is

visible to the human eye.[8] Artificial lighting, while sometimes appearing similar to daylight, notably white light, can be composed spectrally quite differently to natural light and may spread, render colour, or affect physiology differently. The amount of quality of light affects human activities after dark, enabling such activities as commerce, transport, and sport, but possibly impairing such activities as sleep and general enjoyment of the environment moreover ecological processes in artificially lit places may also be affected.

Since Thomas Alva Edison introduced artificial light in the United States in 1879[9], artificial lighting has been of essential importance in modern society and urban living. People are able to prolong their activity period at nighttimes and to use artificial light from premises for specific purposes at night, for example, outdoor working, sports competitions and advertising commercial enterprises.[10] Therefore, artificial light enables experiencing natural night-time lighting conditions in urban areas with prolonged exposure to bright lights during nighttime hours.

However, lighting or illumination from artificial lights at night in the wrong place or at the wrong time, illuminating areas not intended to be lit, can cause disturbance to neighbours and wastes energy.[11] It also has negative effects on ecosystems and interferes with astronomical observations. The growth of urban areas had seen private and public premises requiring high levels of light, and this was achieved by planning development without considering a wide range of environment and development problems.

Light pollution[12] generally includes the various terms that refer to many adverse

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[8] Cuttle, C,, *Lighting by Design*, Architectural Press, 2003, p 19.

[9] Gorman, J., *Detailing Light: Integrated Lighting Solutions for Residential and Contract Design*, 1st edition, Whitney Library of Design, 1995, p 7.

[10] Verges, M., *Light in Architecture*, Tectum Publishers, 2007, p 375.

[11] Gallaway, T., Olsen, N. R. & Mitchell, M. D., *The Economics of Global Light Pollution*, Missouri State University, 2009, p 6.

[12] Pollution generally introduces many forms of undesirable effects in the environment, including on human health. These harmful actions mainly consist of the environmental degradation that is a result of industrial and certain domestic activities. However, unacceptable levels of environmental damage and human suffering may be tackled by contemporary environmental management. For example, electrosmog or electrical pollution brought about the scientific description of the intrusive or inappropriate level of

problems[13], for example, people's quality of life, people's safety, disruption of astronomical observtion with telescopes, impacts of ecological systems, carbon emissions, and harm to the night environment, all of which are caused by excessive or obtrusive lighting[14] as mentioned in Chapters 2 and 3.

Among the many environmental and planning law developments and reforms concerning precautionary light pollution approaches that have emerged in the years since a particular form of unwanted light was identified by astronomers in the 1970s[15], many jurisdictions have adopted legal measures designed to prevent light pollution from excessive or obtrusive artificial lighting at night. The definition of light pollution currently consists of various terms and implications for a wide range of decision-making institutions and stakeholders, but in determining definitions there should be meticulous attention to how exactly the definition of light pollution interrelates with existing forms of light pollution control and to how the definition of light pollution applies to a growing light pollution context and its legal problems such as the environment, energy, crime, astronomy, human rights, health and consumer protection.[16]

The roots of the definition of light pollution in England and other jurisdictions lie with light practitioners, who are to provide specific light pollution terms and contexts for the

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radio frequency (RF) effects of electric fields on human being and the environment when invisible electromagnetic radiation is emitted. Although there is not much scientific evidence that links invisible electromagnetic waves and environmental harm, some countries and municipalities have passed or adopted specific legal instruments to ensure that the concept of precaution has been incorporated into uncertain hazards from electrical pollution.

[13] Karol, D., Ng, M., Varlmova, M. and Walls, G., *The Effect of Light Pollution in Hong Kong*, Worcester Polytechnic Institute and Friends of the Earth, 2010, p 4. Available online from http://www.wpi.edu/Pubs/E-project/Available/E-project-030410-222203/unrestricted/GreenLight_Final_Report.pdf accessed 13 March 2013.

[14] Environmental Protection UK, *Light Pollution*, Environmental Protection UK, 2010, p 3.

[15] In the 1970s, an astronomical light pollution form was identified, that of 'sky glow' or 'atmospheric glow' caused in urban areas and city centre areas. The increasing urban sky glow problem had a specific effect on the ability of astronomers to use astronomical telescopes in proximity to urban areas. See Lewin, I., *Light Trespass and Light Pollution- Practical Approaches to Dealing with Problems*, IESNA Street and Area Lighting conference, Minnesota, September 2000, p 1-21.

[16] Fishter, E., Jones, J. And Schomberg, R., 'Implementing the Precautionary Principles: Perspectives and Prospectives', in Fishter, E., Jones, J. And Schomberg, R. (eds) *Implementing the Precautionary Principle Perspective and Prospects*, Edward Elgar, 2008, p1-16.

management of the night environment, and within environmental law. Many definitions of light pollution generally reflect, or react to underlying aspects of light pollution and its concerns. Likewise, light pollution concepts involve a number of principles of illuminating engineering or lighting architecture which not only embrace night environmental protection and conservation, but also increase the benefits of good lighting practice and lighting governance.[17]

However, there is discussion as to whether the definition of light pollution is adequately regulated.[18] This is a particular legal issue where the ability of current definitions of light pollution cannot cover the extent of light pollution contamination and its risks, including the criteria for identifying hazardous lighting. Necessary contexts of light pollution, consequently, cannot be found to take the necessary or appropriate actions of light pollution control because of the lack of the suitable boundary light pollution definition.

Although previous and current light pollution definitions should give jurisdictions a broad overview of light pollution terms and its main implications for stakeholders in their work, they might have problems making decisions from time to time which cannot be specifically designed to cover all light pollution situations wherever necessary. Accordingly, the legal definition of light pollution should apply in conjunction with other legal terms relevant to or affecting all aspects of light pollution and the implications, terminology or glossary of jurisdictions.

The Department for the Environment, Food and Rural Affairs (DEFRA)'s guidance on light pollution[19] addresses the definition of light pollution and the harms it can pose to

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[17] In setting out or explaining legal light pollution definitions, the definitions of official light pollution laws and regulations should be derived from moral precepts of light pollution practices. So, the fundamental principles of environmental law should envisage a number of subsidiary principles to be considered in due moral and legal courses. See Huges, D., Jewell, T., Lowther, J., Parpworth, N. And Prez, D. P., *Environmental Law*, 4th edition, LexisNexis Butterworths, 2002, pp 17-20.

[18] The welfare of the night environment and human being is therefore to be accorded importance in the legal regime for light pollution control. Current environmental and planning law, therefore, should be based mainly on an philosophy behind anthropocentric approaches for light pollution management. See Thornton, J. and Beckwith, S., *Environmental Law Sweet & Maxwell's Textbook Series*, 2nd edition, Sweet & Maxwell, 2004, pp 6-7.

[19] Department for Environment, Food and Rural Affairs, *Statutory Nuisance from Insects and Artificial*

human beings and the night environment. Light pollution is specifically defined by DEFRA as "*any form of artificial light which shines outside the area it needs to illuminate, including light that is directed above the horizontal into the night sky creating sky glow (which impedes our views of the stars), or which creates a danger by glare*". DEFRA also requires that local authorities identify light pollution problems and ensure that significant risks of light intrusion are dealt with, including how to identify when artificial lights are causing a statutory nuisance, and when and how to use the enforcement powers of local authorities. Unfortunately, DEFRA's guidance on light pollution is not a statutory law. This consequently means that the official functions governing all aspects of light pollution control, including the formal legal definition of light pollution are not set out in numerous Acts of Parliament and many of the current functions have not been specifically associated legal light pollution control duties. This guide by DEFRA has not successfully enabled a clearer picture of the light pollution control requirements on all public or private sectors and created appropriate legal obligations under English legislative frameworks.

England has recently adopted a statutory nuisance measure designed to limit or control light pollution from light intrusion. The English light statutory nuisance from section 102 of the *Clean Neighbourhoods and the Environment Act 2005* specifically creates a form of legal nuisance, namely '*artificial light emitted from premises so as to be prejudicial to health or a nuisance*'. However, the Act does not specifically set out the terms of light pollution light, such as a light pollution remediation obligation and a light pollution remediation requirement. To protect the night environment, it is important that certain light pollution definitions should be established by national and local governments. Light pollution might be defined as the possible forms of national responsibility, including the prospective theoretical and terminological rules. The problem of unclear definitions might lead to wrongful actions or practices where there is conceptual and terminological confusion.

Light Guidance on Sections 101 to 103 of the Clean Neighbourhoods and Environment Act 2005, Department for Environment, Food and Rural Affairs, 2006, p 28.

1.2.2 General definitions of light pollution

Light pollution occurs when spill or misdirected light is cast where it is not wanted. Excessive or obtrusive outdoor lighting emission is able to deteriorate the night environment, nocturnal ecology and human health. Light pollution emission not only affects the environment and natural resources, but it also leads to serious problems for both amateur and professional astronomers. Ability to view the stars by the naked eye and telescope is affected by glow or upward lighting. So, the negative effects of light pollution impact on astronomy observation. The disappearance of a starry sky and the Milky Way at night is a concern for the heritage of astronomy and its conservation. Consequently, many light pollution issues are found by astronomical bodies and other stakeholders. Many astronomical bodies and associations have attempted to persuade international and national environmental authorities to define the term of light pollution.

The Illuminating Engineering Society (IES) and International Dark Sky Association (IDA) define light pollution as "*Any adverse effect of artificial light including, but not limited to, glare, light trespass, sky glow, energy waste, compromised safety and security, and impacts on the nocturnal environment.*"

While the IES and IDA suggest that a definition of light pollution could be made more easily understood by all relevant stakeholders, they cannot be certain that the definition contains all elements of light pollution. There are examples of where the lack of some light pollution detail for light pollution definition in model law or statutory law has caused difficulty to involve all aspects of light pollution.

Likewise, light pollution is also defined by the UK's joint Countryside Commission and Department of Environment's guidance that "*Light is a type of radiation and forms part of the electromagnetic spectrum visible to the eye. It is measured in lumens (lm). A modern electric light takes in energy in watts, and its efficiency can be measured in lumens per watt (lm/w). The amount of light falling on a surface is know as the illuminance and is measured in lumens per square metre or lux. This is easy to calculate and measure and is therefore widely used. The illuminance of direct sunlight is approximately one hundred thousand lux, but normal daylight, which is filtered*

through a cloudy sky is between five thousand and ten thousand lux, while moonlight is as little as 0.25 lux.

Luminance, or brightness […] is directional and is measured in candelas per square metre (cd/m2).

The other term commonly used by lighting engineers is luminous intensity. This refers to the strength of light in a given direction and is measured in candelas (cd). However, in reality, a source's luminous intensity is seen by the eye relative to the brightness of its surroundings, and this is not easy to measure."[20]

However, the UK's Joint Countryside Commission and Department of Environment's guidance does not beneficially help the public sector and local authorities to ensure that this context of lighting particularly complies with lighting regulations designed to protect the night environment as well as other adverse impacts of light pollution. A wide variety of styles for various lighting aspects have been normally termed by the UK's Joint Countryside Commission and Department of Environment's guidance, although there is no specific introduction of a precise light pollution definition for deliberate environmental impacts.

Cinzono et al. also refer to a definition of light pollution as "*the alteration of the ambient light levels in the night environment produced by man-made light.*"[21] Gallaway, Olsen and Mitchell used this light pollution definition for their first research of the economic factors of global light pollution. Their paper uses unique remote sensing data and economic data from the World Bank to quantify the economic causes of light

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[20] House of Commons Science and Technology Committee, *Light Pollution and Astronomy Seventh Report of Session 2002–03*, House of Commons Science and Technology Committee HC 747-I, 2003, p 17. and see UK Parliament, *The extent and nature of light pollution*, available from http://www.publications.parliament.uk/pa/cm200203/cmselect/cmsctech/747/74706.htm accessed 18 March 2013.

[21] Cinzano, P., F. Falchi and C.D. Elvidge. 'The First World Atlas of the Artificial Night Sky Brightness.' *Monthly Notices of the Royal Astronomical Society*, 2001, 328,689-707. and See Cinzano, P., W. F. Falchi, C. D. Elvidge and K. E. Baugh. 'The Artificial Night Sky Brightness Mapped from DMSP Satellite Operational Linescan System Measurements.' *Monthly Notices of the Royal Astronomical Society*, 2000, 318, 641-657.

pollution globally.[22]

The same theme was similarly defined by Hollan, in '*What is light pollution, and how do we quantify it?'* The definitions specifically extended the foreseeable risks to both outdoors and indoors. Outdoor light pollution is definded as "*The alteration of light levels in the outdoor environment (from those present naturally) due to man-made sources of light.*"[23] Nevertheless Hollan also emphasised indoor light pollution on the basis of indoor lighting conditions from windows and the outdoor environment. Indoor light pollution is optionally defined as "*Indoor light pollution is such alteration of light levels in the indoor environment due to sources of light, which compromises human health.*"[24] In light of Hollan's approach, whilst there are distinctions between outdoor and indoor light pollution the significant terms of indoor and outdoor lighting practices seem to relate to particular definitions of light pollution and harmful risks. Therefore, light pollution definitions concerning the required themes of negative risks on light pollution should be suggested or recommended that the foresight of the relevant kind of harmful risks of light pollution would be required by each terminology.

In addition, it is a brief analysis of the respective weaknesses of Cinzono et al. and Jan Holland's light pollution definitions. The definitions of "*light pollution*" in both Cinzono et al. and Jan Holland's perspective are thought to include "*man-made light*" or "*man-made sources of light*". These perspectives involves all man-made light, such as useful lights and unwanted lights. Therefore, light pollution definition should be existed carefully and meaningfully by the components or contexts of any particular light pollution. The wrong use of the light pollution terms can lead to misunderstandings of light pollution aspects because one of the most important components for successful light pollution control is clarity of the right context.

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[22] Gallaway, T., Olsen, N. R. & Mitchell, M. D., *The Economics of Global Light Pollution*, Department of Economics, Missouri State University, 2009, available from http://www.missouristate.edu/assets/econ/world_light_pollution.pdf accessed 18 March 2013.

[23] Hollan, J., *What is light pollution, and how do we quantify it?*, N. Copernicus Observatory and Planetarium, Brno, April 2009 available from http://amper.ped.muni.cz/light/lp_what_is.pdf accessed 18 March 2013.

[24] Ibid.

Among existing light pollution problems, is that each light pollution definition from different texts, cases and materials can be implemented in different ways, depending on the light pollution context and their voluntary light pollution management system. So, the legal definitions can technically address the light pollution context on the environmental and planning frameworks. The shape and content of the definition of light pollution can be certified by special identification or a specific awareness, for example, Longcore and Rich distinguish "*astronomical light pollution*", which obscures the view of the night sky in the night environment, from "*ecological light pollution*", which alters natural light regimes in terrestrial and aquatic ecosystems at night.[25]

Furthermore, light pollution laws are applied to an extraordinary diverse array of light pollution issues in all forms. The regulatory frameworks of light pollution control generally present various paradigms for the delineation of modern public decision-making.[26] A number of light pollution laws have emerged in cross light pollution studies of environmental and planning laws. The light pollution paradigm seeks to identify the light pollution forms and their contexts, whether in many jurisdictions.[27] As a consequence, they might be based on the legal measures and regulatory frameworks for the night environment preservation or human health protection[28], for example, a statement of light pollution findings and purposes, a substantive standard for night environment preservation as well as lighting standardisation.[29] Accordingly, definitions should be determined by establishing a current paradigm of allocation. It can influence

[25] Rich, C. and Longcore, T, 'Ecological Light Pollution', *Frontiers in Ecology and the Environment*, 2004, 2(4), pp 191-198.

[26] Plater, J.B.Z., 'In the Wake of the Snail Darter: An Environmental Law Paradigm and Its Consequences', *Journal of Law Reform*, 1986, 19 (4), pp 805-862.

[27] Brooks, O. R. & Virginia, A. R., Law and Ecology The rise of the ecosystem regime, Virginia: Ashgate, p 33.

[28] In addition, environmental justice relating light pollution is consequently restricted to concerns about humans and their well-being. See William S. L., 'Geography, Value Paradigms, and Environmental Justice', *Newsletter of the Society for Philosophy and Geography*, March 1995, pp 2-4.

[29] Statutory nuisance is seen as a beneficial umbrella by the UK Parliament for dealing with localised environment and health problems in England. The specific statutory nuisance provisions of the Clean Neighbourhoods and Environment Act 2005 significantly provide for the first time that light pollution should be included as a statutory nuisance. Several years ago, it was intended that the cumbersome issues of high obstruction should be dealt with as a new type of statutory nuisance, on the other hand, in the event, this was included in other framework. See Malcolm, P. & Pointing, J. 'Statutory Nuisance: The Sanitary Paradigm and Judicial Conservatism', *Journal of Environmental Law*, 2006 18 (1), pp 37-54.

over-establishing determination of environmental and planning law and policy. While definitions from a traditional paradigm of environmental and planning laws appear to influence some jurisdictions' environmental control, the legal research evidence on whether relationships between definitions and some other contexts actually influence environmental control frameworks from each jurisdiction is less clear, for example, common behaviour in housing energy consumption and energy saving culture.

A light pollution definition may contain not only a traditional model of lighting frameworks, which have the purpose of directing light pollution management but also lighting frameworks which are regulatory in nature. In so far as this research seeks to explore the relationship between a light pollution definition, and environmental and planning law, within a broader context of environmental law principles and specific legal measures dealing with light pollution control, this research relies on the future development of a light pollution definition.

When a model lighting framework or other academic papers establish light pollution definitions and their contexts, some of the lighting aspects of illuminating controls and lighting practices problems encountered in each lighting aspects may be reformulated in light pollution terms. Each context of a definition of light pollution is particularly separated to highlight the extent to which the light pollution aspects in question must apply to some aspect of light pollution control.

This research also provides extrapolation on that the formulation of light pollution definition according to knowledge at the time of publication of this research. However, this research does not change the legal definition of light pollution and it does not take precedence over the formulation of a light pollution definition.

The definitions of light pollution can be used for fulfilling lighting practice and law enforcement in the future. The precise meaning of light pollution is of academic importance. However, the definition by general academic sources will probably not be sufficient. The statutory interpretation of light pollution documents or the solution to a light pollution problem may be based upon the exact meaning of light pollution aspects and its context. Determining whether a terminology of light pollution is made for

general scientific studies might be difficult because it is not always easy to apply the general scientific definition of light pollution. If lights from premises created excessive or intrusive light pollution, the definition should generally be considered a specific legal definition made for national and local jurisdictions.[30] The term of light pollution in the definition may differ from other pollution definitions, for example, air pollution and water pollution. For the purposes of light pollution control, light pollution should mean for various aspects of statutory interpretation and legal presumptions that further a clearly expressed light pollution control purpose.

To help determine what light pollution is, the statutory frameworks may identify specific terminology of light pollution that involves a written term of light pollution. The specific definition of light pollution may fulfil the legal meaning and give precedence over the legal interpretation of court decisions. The development of lighting practices and professional lighting standards can be greatly influenced by legal terms rendered by law makers, as well as by court judgments, such as those made by national governments and local authorities. For these reasons, the style of a legal light pollution definition established by English environmental and planning law, may be described as a single legal definition of light pollution within a statutory framework. According to previous debates about several working general light pollution definitions, there were three significant reasons for reforming a single legal definition of light pollution in light of the statutory terminology: (1) Several general light pollution definitions were failing to deliver the single standard of environmentally friendly lighting and environmental protection that all relevant stakeholders had the right to expect; (2) The terminology of light pollution was inefficient confusing, and lacked integration for all relevant multidisciplinary approaches for light pollution control; and (3) There was a single legal definition of light pollution that would reflect all aspects of non-environmentally friendly or inefficient lighting where various risks of energy wastage, ecosystems and of interference with astronomical observations have been foreseen by all relevant stakeholders.

[30] Congressional Research Service, *Statutory Interpretation: General Principles and Recent Trends*, Congressional Research Service Order Code 97-589, 2008, p 5-6.

Additionally, light pollution has an effect on human health, energy wastage, safety, security, interference with astronomical observations and the night environment all of which raise legal issues. These issues, for example, raises complex questions of whether certain limits to protect public health and welfare are based upon the day-night light levels regarding acceptable or unacceptable degrees of non-environmentally friendly light interference and inappropriate light annoyance. To address light pollution in environmental and planning law, this research then asked whether statutory law should produce a single terminology, about which a single legal definition of light pollution that integrates multidisciplinary aspects of harmful light pollution may be made. In Chapter 4, an analytical outline will be provided of this research's recommendations. It will be discussed in detail again throughout Chapter 4.

Urban light pollution has become a reality, especially in urban brightness areas, such as city centres with high levels of night time activity. This is of concern to many national governments, local governments and other lighting governing bodies because light pollution can have many negative impacts on the quality of the night environment. So, the need for more coherent strategies and frameworks to prevent inappropriate lighting fixtures and design should be done by national government, local governments and lighting governing bodies.

The environmental and planning problems associated with the lighting frameworks are becoming more recognised as a source of pollution. The problems of light pollution first became an issue in the 1970s when professional and amateur astronomers identified the degradation of the night environment due to the increase in lighting associated with urban sprawl.[31] The ability to view the stars, sky objects and Milky Way is interfered with by light pollution at night. The increase in urban light pollution caused by urban development specifically makes it difficult to see dim atmospheric objects at night.[32] Whilst important have of artificial lighting for public and private premises in

[31] Illuminating Engineer Society & International Dark-Sky Association, *Joint IDA - IES Model Lighting Ordinance (MLO) with User's Guide*, Illuminating Engineer Society, 2011, p 2.

[32] International Dark-Sky Association, *'The Problem with Light Pollution', International Dark-Sky Association (IDA) — Information Sheet #1*, available from http://www.darksky.org/assets/documents/is001.pdf accessed 11 March 2013.

development areas, urban lighting from sky glow significantly affects the night sky environment or dark sky heritage. Astronomical observations are recognised and perceived by mankind. Awareness of the importance of dark sky heritage and natural night environment has been developed by naked-eye star visibility and astronomical telescopes. The impact of light pollution on the environment is able to alter the natural patterns of light and dark in ecosystems. The lack of natural light in regulating species interactions consequently effects the biology and ecology of species in the wild. Therefore, the ecological consequences of artificial light must be recognised by scientists and law makers.

Light pollution not only affects astronomy and the ecological environment in many negative ways, but also causes energy waste. Energy wasting light design and fixtures use energy for unnecessary or inappropriate lighting from public and private premises.[33] Artificial lights at night in the wrong place or at the wrong time can result in a waste of valuable energy. Increased energy consumption can change the efficiency, intensity and output of electricity generation.[34] Energy consumption of lighting products had significantly increased energy intensity in the public and private sectors. Energy is wasted. Million tons of carbon dioxide in generated emissions put the energy costs due to wasted lighting.

Lighting governing bodies who are made up of lighting practice professionals are generally responsible for lighting design within the industry and would seem to be one of the main groups involved in improved lighting design and installation if we are to reduce light pollution. This is not least because much energy may be wasted due to incorrect lighting and installation, for example poorly aimed fixtures.

Furthermore, to address a broad range of light pollution issues, the legal and policy frameworks should be developed to protect the natural night environment and ecology, including energy saving. Central and local governments should provide specific guidance on relevant law, policy and practice, for use by lighting professionals, light

[33] University of Exeter, *Low Energy Artificial Lighting*, Exeter, University of Exeter, 2013, p 23.
[34] Curtis, D., *Predictions for the contribution of residential lighting to the carbon emissions of the UK to 2050*, Environmental Change Institute, University of Oxford, 2013, p. 1.

industry, business sectors and people. Architects, lighting designers, and consultants, and others connected with lighting and illumination may follow lighting standards based upon best practice, but adherence to these codes of practice is entirely voluntary[35] and lacking effective enforcement in some national and local jurisdictions. Lighting professional bodies have occasionally introduced models of effective legal frameworks, but there is inadequate legal adaptation to seek redress for best lighting practices and light pollution control.[36]

The model laws of lighting professional bodies[37] can become concrete through national and local light pollution laws and regulations. They merely offer model laws that might be able to require such undertakings to be applied into national and local jurisdictions' legislative frameworks. To achieve the objectives of the environmental approaches, many jurisdictions rely on various principles of environmental law, which are outlined under their national and local environmental laws and regulations, for example, the principle of sustainable development, the principle of precaution, the principle of prevention and the principle of cooperation. While astronomical organisations have a keen interest in the reduction of light pollution and may take an active role in campaigning for the development of such model law, legislation to protect the dark-sky environment has not been adopted in plenty of jurisdictions in the world. This also means that several jurisdictions do not allow fundamental principles of environmental law to be applied by national, regional or local government institutions.

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[35] Institution of Lighting Professionals, *Guidance Notes for the Reduction of Obtrusive Light GN01*, Institution of Lighting Professionals, 2011, pp 1-10.

[36] Morgan-Taylor, M, 'God Divided the Light From the Darkness: Has Humanity Mixed Them Up Again?', *Journal of Environmental Law and Management*, 1997 9 (1), pp 32-39.; Hughes, D. & Morgan-Taylor, M, 'And Can't Look up and See the Stars', *Journal of Environmental Law* 2004 16 (2), pp 215-232.

[37] For example, *Joint IDA - IES Model Lighting Ordinance (MLO)* is aimed at providing the light pollution model law for the various stakeholders who will use it: lighting designers, city officials, engineers, citizen groups, and others. Each guideline has been provided in order to keep the light pollution and its technical terms, but since different disciplines may practice the same term in different contexts, or have different interpretations, some guidance may be useful. See Illuminating Engineer Society & International Dark-Sky Association, US *Joint IDA - IES Model Lighting Ordinance (MLO) with User's Guide*, available from http://www.ies.org/PDF/MLO/MLO_FINAL_June2011.pdf accessed 11 March 2013.

In most cases controlling and managing emission of excessive or obtrusive outdoor light by adopting more appropriate regulatory measures will enable local authorities and their inhabitants to reduce the levels of light pollutant emissions. So, light pollution is able to identify a number of actions local authorities and their inhabitants must commit to reduce efficient light consumption and emissions of light pollution.

National and local jurisdictions have adopted many different approaches to tackling light pollution through the promotion of environmentally friendly or appropriate outdoor lighting practices. Indeed, the Government adopting the legal aspects of practical application for tackling light pollution appears to be by a specific statutory nuisance.[38] However, in relation to the current law, it has been argued that all aspects of light pollution should be more descriptive, as the purpose of a wide variety of lighting practices of foreign jurisdictions is to encourage considerations of environmental impacts at an early stage in planning and environmental practices. All lighting governance must be integrated in every decision and action. Artificial light statutory nuisance provisions alone are very small and a weak step, unless all policies, decisions and frameworks are subject to all aspects of light pollution, not only those initiated by the environmental and planning guidance.

This research has therefore been driven by the legal reasons referred to above and looks into comparative light pollution laws and jurisdictions to investigate the ineffective usage of current legal instruments to control light pollution. It will endeavour to investigate the problem of the previous and current light pollution frameworks in England and other foreign jurisdictions, the shortcomings of existing legal measures and how they can be improved by the UK Government. Furthermore, we will clearly make an explanation of how environmental and planning law measures have been enacted to protect England's night environment. It is neither a restatement of environmental law from a comparative perspective, nor is it a compilation of comparative environmental and planning law studies. Rather, it introduces the essentials of light pollution control

[38] Department for Environment, Food and Rural Affairs, *The Royal Commission on Environmental Pollution (RCEP) Report on Artificial Light in the Environment*, Department for Environment, Food and Rural Affairs, 2010, at paragraphs 1-7.

that should be considered in any serious examination comparing the environmental laws of different national and local jurisdictions.

In conclusion, this subheading would lead to a much greater understanding and clarity on a wide array of general light pollution definitions if these debates were read by all relevant light stakeholders. It also recognises that debating some dominant working light pollution definitions can present unique challenges for reforming a single legal definition of light pollution when this research analyses how legislatures and policy makers will use their newly acquired multidisciplinary light pollution definitions to address the failures of considering the impacts of non-harmonisation of a single legal light pollution definition in England highlighted by the debate in Chapter 4.

1.3 Research Questions

This research study focuses on aspects of light pollution legislation which are analysed under comparative international, European, foreign jurisdictions. So, the research hypothesis is a prediction of the outcome of a comparative legal study that is based on the theoretical and overseas law approach. Many legal issues raised by this research concern the underpinnings of comparative environmental and planning law. The constraints and limitations of English statutory law are indicated by a critical appraisal of the comparative legal method.

The research questions are:

> Chapter 2: How does light pollution effect the night environment and human well-being?
>
> Chapter 3: How many different causes of light pollution are there?
>
> Chapter 4: What is a single legal definition of light pollution?
>
> Chapter 5: Can five key principles of environmental law (i.e., sustainable development principle, prevention principle, precaution principle, polluter pays principle and cooperation principle) be widely accepted that each basic principle should be invoked in deciding how light pollution control should be

addressed?

Chapter 6, 7 & 8: Can the existing national, European, and international regulatory frameworks be taking legal actions against key elements of light pollution? Which jurisdictions have adopted legislation designed to limit light pollution from outdoor lighting? How important is comparative legal research for national light pollution control law reform?

Chapter 9: How does a comparative legal analysis on different example jurisdictions on the subject of light pollution control critically explore the main elements of law reforms in regards to light pollution control in England?

1.4 Objective of the thesis

This research attempts to explore an approach to English light pollution control law reform. The aim is to find the lacunae in existing English light pollution law and the need for setting new regulatory measures to control outdoor light pollution and to review the significant opportunities and challenges for light pollution law reform in England. In other words, this research examines why and how comparative legal analysis of the common and civil law on the subject of light pollution control critically explore the main elements of law reforms regarding light pollution control in England. In addition to using comparative legal methodologies for the English legal system and other jurisdictions, this research endeavours to analyse the study of statutory interpretation and forms of legal argument within different functional jurisdictions.

In broad terms, the objective of this research is to develop reasonable recommendations for reform of insider dealing with the legal reform of future English light pollution frameworks. This research is to have a reasonable guidance of English environmental and planning law reform introduced to the UK Parliament. The guidelines the research needs to address are whether there are new legal approaches and dimensions it could pursue to deliver better outcomes for the night environment and human beings, whilst at the same time reducing unnecessary or inappropriate lighting usage and promoting best practice of light pollution control.

This research aim looks at the comparative legal methodologies of light pollution legislation, redress and enforcement arrangements regarding national and local jurisdictions that underpin the core legal principles of protecting the night environment and human beings in England:

1. To explore many effects and causes of light pollution.

2. To explore several contexts of a single legal light pollution definition.

3. To outline five key principles of the current environmental and planning law relating to light pollution control.

4. To review key international and European frameworks for setting levels of international and European light pollution awareness.

5. To compare between eight example jurisdictions where they have identified light pollution harms and adopted legislation designed to control outdoor light pollution from non-environmentally friendly fixtures and inappropriate design.[39]

6. To conclude there are differences of legal indicators, regulatory measurements and enforceable measures under eight example foreign laws and these also outline the key conclusion and recommendations contained in the final Chapter (Chapter 9) which should build on English law reforms in the future.

1.5 Research methodology

A hypothesis can be clearly defined as a magnificent explanation of the lacunae in existing English light pollution law and the need for setting new regulatory measures to control outdoor light pollution. The hypothesis critically evaluates the lacunae in existing English light pollution law.

Within the context of interdisciplinary legal research in light pollution legislation, an essential element of this research represents legal knowledge about the operation of many national and local light pollution frameworks, and multidisciplinary knowledge of

[39] See On functions and aims of comparative law See Kotz, K. Z., *An Introduction to Comparative Law*, 3rd edition, Oxford University Press, 1998, pp 13-31.

the same kind context which has been produced with specific purpose in mind. This research concerns with the systematic presentation and appropriate planned objectives and is therefore referred to as the research methodology in this legal research. The research method used in this thesis will be the comparative law technique[40] which becomes necessary to fill the gap in the English law.[41] The comparative law approach is a specific study of the similarities and differences between the laws of two or more countries, or between two or more legal systems. In the case of environmental and planning law, the comparative approach involves the recognition of many legal elements and different approaches, as well as the future challenges faced, in drafting national and local environmental and planning legislation.

Comparative environmental and planning law approaches, evaluated across nations and local areas through the techniques of comparative law, serves as an indicator of the success or failure of the English nation's measures to attain light pollution control. Since this research is to modernise the English light pollution control framework by providing the necessarily light pollution control requirements. Comparative law is objective, which is an appropriate technique.

This research has documentary supplements which are useful sources of legal materials. Documentary legal materials are generally divided into two categories[42]: primary and

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[40] On legal comparative methods See Berman, A. G. et al., 'Comparative Law: Problems and Prospects', *American University International Law Review* 4 (26), 2011, pp 935-968.; Zumbansen, P., 'Comparative Law's Coming of Age? Twenty Years after Critical Comparisons', German *Law Journal* , 2005, pp 1073-1084.; Eberle, J. E., 'The Method and Role of Comparative Law', Washington *University Global Studies Law Review* 2009 3 (8), pp 451 - 486.; Smits, M. J., Comparative Law and its Influence on National Legal Systems, in: Reimann M. & Zimmermann R. (eds.), *The Oxford Handbook of Comparative Law*, Oxford University Press, 2006, pp. 513-538.

[41] The contemporary significance of comparative law is recognised by this research. The comparative method will offer several discussions and suggestions on many aspects of comparative light pollution laws, in the domestic law arena and in the context of the local law arena. Accordingly, comparative legal approaches are able to examine the various lighting control functions under the following contexts: comparative law as a prospective discipline; comparative law as an aid to future English light pollution law reform; comparative law as an instrument of light pollution control construction; comparative law as a means of understanding light pollution law; comparative law as a contribution to systematic unification and harmonisation of the future EU light pollution frameworks. See Cuuz, D. P., *Comparative Law in a Changing World*, 3rd edition, Routledge-Cavendish, 2007, p 18.

[42] Oesterle Library Information Literacy & Instruction Program, *Primary and Secondary Sources in Law*, available from http://library.noctrl.edu/subject/business_law_primary_sources.pdf accessed 11 March

secondary. Primary sources are those which state the law - statutes, statutory instruments, codifications, court decisions and law reports. Secondary materials discuss, interpret, explain and comment on the law and include law textbooks, journal articles, law reviews, legal dictionaries, encyclopaedias. Consequently, each documentary legal material offers its useful comparative contexts which introduce many environmental and planning law comparisons regarding light pollution control that will be investigated and analysed in the research. Documentary supplements will clarify the theoretical light pollution control which is made for this research study.[43]

Comparative legal analysis from this research will be used to examine many relevant sources of light pollution control law relating to several common law and civil law jurisdictions where adopted legislation has been designed to limit light pollution from lighting design and fixtures.[44] The main act in comparison is looking at differences and similarities between the light pollution control measures and frameworks which are be able to enlighten future requirements when the British Government seek to reform and improve lighting control obligation. Even more importantly, the result of our research investigation needs to be examined and carefully considered in relation to various methodological and theoretical approaches to comparative light pollution jurisdictions.

English law fails to provide a clear light pollution control mechanism for all light pollution types and impacts caused by excessive or intrusive lighting practices. An alternative approach is to have comparative environmental and planning law studies dedicated to light pollution issues. Even though key example jurisdictions, for example, Japan, France, Italy, Slovenia, U.S., Chile, Canada and Spain, have used lighting

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2013.

[43] However, the ideal context of comparative legal approach in the national courts is not confined to cases where foreign legal materials are considered and decided. A comparative legal approach is omnipresent in a whole range of decisions. See Samuel, G., '*Comparative Law and the Courts*' in Cannivet, G, Andenas, M. and Fairgrieve, D. (eds), Comparative Law before the Court, British Institute of International and Comparative Law, 2004, p 256.

[44] Light pollution issues are universal; comparative environmental and planning law can respond to these needs in several ways. However, incomparable aspects cannot be usefully compared; for example, the functional-institutional approach does not solve the issue of comparability between a Western legal system and a religious legal system. See Orucu, E., 'Developing Comparative Law', in Orucu, E. and Nelken, D., (eds) *Comparative Law A Handbook*, Hart Publishing, 2007, p 52.

restrictions on the light types and duration of illumination permissible in an attempt to control excessive or obtrusive lighting[45], the UK Government has not provided the specific creation of statutory outdoor lighting control which tackles all light emission. While analysing different resolutions on revitalisation, this research realised that there are many measures which can be explored by best practice advice and recommendation in the future.

So that we may better organise comparative analysis and make the findings more understandable and useful, this research has divided the relevant light pollution provisions into comparative clusters of national and local jurisdictions and their dominant legal measures. The benefits of comparative light pollution legislation significantly lead to knowledge of more than simply other countries' laws.[46]

Although statutory light nuisance was substantively established in 2005, this leads to questioning of the effective standards of a better light pollution solution in England, where there is currently no obligation on all aspects of light pollution problems to make specific criteria of light pollution control. Therefore, this comparative law research develops an academic consultation on light reform of English light pollution law. To conduct research in order to develop systematic guidance for useful consideration by public authorities and other stakeholders, a comparative legal analysis can particularly underline different approaches towards comparison of national jurisdictions.

To set down the written statutory law, the procedure of bringing together a legislative framework and all its amendments in a single new act can rearrange many areas of earlier statutes where the environmental and planning laws are not updated through the UK legislative process. This comparative legal research describes and contemplates the comparison of various problems of the written laws; the objective of which the written law can modernise the English light pollution law. Even though codification is not a

[45] The light pollution law research or investigation in comparative law accordingly involves working within other aspects of illuminating engineering and lighting architecture, including other legal fields of light pollution law research, for instance consumer law, industrial law, energy law or jurisprudence. See Bogdan, M., *Comparative Law*, Kluwer Law and Taxation Publishers, 1994, p 24.

[46] Watt, M. H., 'Globalization and Comparative Law', in Reimann, M. and Zimmermann, R., *The Oxford Handbook of Comparative Law*, Oxford University Press, 2007, pp 583-592.

specific term of art in English common law, nevertheless the problem of coexistence of statutory law with judicial decision has to be faced whatever course the development of future light pollution law takes. A statutory framework, which takes the common law in certain or specific areas of environmental and planning law and puts it in statute or code form, can progressively bring amendment and modernisation of the future light pollution provision involving other legal aspects related to light pollution issues, for example, to require that lights and lamps that contain light pollution related products be labelled accordingly, and for other warning purposes of inappropriate light fixtures and design, the consumer rights to should be specifically adopted by the UK Parliament for setting up the right to environmental health and right to consumer education associated with light pollution environmental harms and human being impacts.

This research not only introduces a comparative legal study of the similarities and differences between selected light pollution jurisdictions, but it also discusses and analyses environmental law theories and principles, for example, the principle of sustainable development, the precautionary principle, the preventive principle and environmental justice. This comparative legal study can analyse a number of environmental and planning principles which are at the centre of environmental pollution control. This research also illustrates the similarities and differences between basic principles of environmental pollution control associated with light pollution. It addresses both the beneficial recommendations to gain a better knowledge of the general principles of environmental and planning law and the future attempts of England to develop adequate legislation to meet the minimum requirements of the light pollution control, as well as the setting relevant criteria of the best lighting practice. Furthermore, some economic or market-based instruments to control the behaviour of light pollution polluters are introduced by this research. The energy costs of controlling light pollution to the extent required by the specific law should be highlighted by a comparison between the general principles of environmental pollution control as well as specific economic instruments on light pollution control and management, such as polluter pays principle (PPP) and other relevant principles.

1.6 Structure and outline of the thesis

This research is to develop a critical discussion and analysis which is designed to represent many environmental and planning problems dealing with light pollution. This research focuses on a literature review which examines a legal hypothesis concerning the future establishment of English light pollution frameworks and schemes. While all aspects of light pollution issues of the environment are not now covered by previous or current legal frameworks, this research has resulted in a strengthening of specific legal measures and schemes associated with light pollution control. Equally, the literature review is also particularly concerned with the non-existence of legally binding obligations and lack of light pollution knowledge by people.

Therefore, the introductory chapter of this thesis plausibly provides a clear outline and structure. It presents theories and concepts concerning light pollution impacts. The specific problems of light pollution and legal problems in England are identified by critical analysis. Indication of all light pollution aspects that have been done on each chapter, demonstrating the gaps and lack of light pollution control measures in England that the proposed research fulfilled.[47] The Comparative law method, as the main instrument of this research, identifies national and local functions within light pollution control measures, including each national and local legislative framework associated with light pollution control. The legal comparison is a critical method for providing solutions to the legal problems raised by comparative studies. The jurisdictions chosen for comparative legal analyses are evaluated into Chapter 8.

This research consists of an introductory Chapter, eight Chapters and a conclusion. The structure and outline of the thesis will support future development of reforms to England's frameworks of light pollution control, including future consultation and guidance for legal reform.[48]

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[47] Comparative research can help in redesigning the specific legal measures to make each even appropriate to specific best lighting practices or light pollution control. See Gordley, J., 'The Universalist Heritage', in Legrand, P. And Munday, R., (eds) *Comparative Legal Studies: Traditions and Transitions*, Cambridge University Press, 2006, p 44.

[48] Markesinis, B. S., *Foreign Law & Comparative Methodology A Subject and A Thesis*, Hart Publishing,

Chapter 1: Introduction

In order to demonstrate light pollution definitions and set the light pollution scene and legal problem statement, this Chapter presents an overview of research in narrative detail. This chapter introduces an overview of concepts of light pollution, negative impacts and legal problems in England and defines the ways in which the three are interrelated. Many questions about this research serve as the main theme: How does comparative legal analysis on the common and civil law jurisdictions on the subject of light pollution control critically explore the main elements of law reforms regarding light pollution control in England? This chapter follows with the legal limits of light pollution control measures in England and introduces comparative legal method, which serves as an indicator of the success or failure of the English nation's measures to attain light pollution control.

Chapter 2: Light pollution effects

This Chapter identifies negative effects of light pollution. Light in the wrong place at the wrong time is allowed to illuminate or intrude upon areas not intended to be lit. Light pollution is generally associated with negative effects on human beings and the night environment. So, establishing how light pollution affects the night environment and human beings as a critical question can set out to raise sustainable awareness of the impact of light pollution.

Chapter 3: Causes of light pollution

Light pollution can affect the environment and human health in many ways. Therefore, different causes of light pollutants affect the environment and human health in different ways, depending on their specific properties and lighting sources. So, this Chapter introduces a number of causes of light pollution allowed to inappropriately illuminate or obtrusively intrude upon areas not intended to be lit. As a base for discussing the results in the next Chapters of this comparative law thesis, how different types of lighting can create different levels of light pollution is discussed and analysed.

1997, pp 352-354.

Chapter 4: Legal light pollution definition

How people can understand what a single legal definition of light pollution is? This Chapter is responsible for adding meaningful academic debate, developing characterisation of light pollution, and unifying a single legal definition of light pollution where necessary, including through different disciplinary solutions. It especially recognises the need for further detail on unification of legal contexts of the light pollution definition.

Chapter 5: Key elements of environmental law

This Chapter responds with critical analysis of five key principles of environmental law (i.e., sustainable development principle, prevention principle, precaution principle, polluter pays principle and cooperation principle) applied or codified in several international, European and national frameworks to which jurisdictions are committed or obligated.

Chapter 6: International light pollution law

Although international legislation designed to limit light pollution from energy usage is adopted by the national government, but it may also have national and local impacts. National governments must enforce and implement international environmental measures. The UK is one of Member States of the Kyoto Protocol, an international agreement linked to the United Nations Framework Convention on Climate Change with a legally binding greenhouse gas emission reduction commitment. Light pollution, coming from wasted light energy, increases carbon emissions and wastes money at the same time. So, this Chapter critically reviews a number of international environmental frameworks and other relevant materials in international light pollution control law, which primarily establishes a number of international awareness. It is intended to raise legal awareness about the possible international actions that may be taken to reduce and prevent the adverse impacts on human health and the night environment.

Chapter 7: European light pollution law

This Chapter critically analyses why the EU should regulate a single light pollution

framework, and how its existing regulatory framework could regulate, based on the contexts of the EU regulatory regime. The EU may need to be ensured that outdoor economic lighting activities and some domestic household lighting activities will not damage human health and the night environment. Additionally, the EU does not currently ensure that light pollution is controlled in the EU. In the absence of internationally agreed scientific methods for measuring light pollution impact, light pollution is not addressed by the existing EU Directives. However, this Chapter investigates whether England should provide objective analysis and effective solutions that address the challenges facing the current EU frameworks, for example, *Ecodesign Requirements for Energy-using Products (EuP) Directive 2005/32/EC* and *Eco-design of Energy-related products (ErP) Directive 2009/125/EC.*

Chapter 8: Light pollution law in different countries

This Chapter cites eight key example jurisdictions where they have identified light pollution harms and adopted legislation designed to control outdoor light pollution from non-environmentally friendly fixtures and inappropriate design. For example, some sample jurisdictions choose to make rules to address the environmental risks of outdoor light pollution or the use of the appropriate mechanism for setting illuminating areas, illumination levels, shielding requirements, and illuminated light curfews. Citing these, the example legislation included in this comparative law research contains detailed foreign light pollution frameworks covering all of the key philosophy, mechanisms, instruments, and metrics of light pollution control, demonstrating how these examples set out in this Chapter will apply to English light pollution control rules made to follow significant standards from the eight sample jurisdictions which relates to that national or municipal control, and allowing the English light pollution control to be further strengthened through comparative law approaches.

Chapter 9: Can comparative law method offer appropriate explore necessary approaches for English light pollution law reform?: Future challenge & opportunities

This Chapter makes a comparative analysis on key example jurisdictions on the subject

of light pollution control. This Chapter also critically indentifies the differences and similarities of foreign legal systems. It assesses whether legal measures from both common and civil legal systems designed to control light pollution from all aspects should affect the abilities of light pollution control in the future. This Chapter also analyses whether future law reform plays a significant part in shaping the reasonable expectations in light pollution control and, as such, influences the level of night environment quality that the specific legal measures associated with light pollution control can be expected. Providing clear light pollution control standards for England would help standardise good lighting and reasonable lighting practices, clarifying what good night environment quality can be expected by specific lighting practices, and increasing the quality of the night environment. This Chapter also examines future approaches in light pollution law reform, to ensure that legal measures protect a natural environment at night, as the foundation of national and local prosperity and wellbeing. The comparative law can establish an integrated approach to light pollution control in the future. Finally, to achieve all of benefits of the statutory law reform in the future, the conclusion and recommendations summarise the key findings of the future legal indicators, regulatory measurement and enforceable measures that are about taking various smarter approaches to sustainable, preventive and precautionary light pollution control. The future legal measures need to take more specific approaches to deal with the light pollution problems that pose a threat to England's night environment.

Chapter 2: Light Pollution Effects

2.1 Introduction of adverse effects of artificial light

This Chapter explores the key effects of light pollution, which can result in serious adverse impacts, including on astronomy, ecology, human health, energy, climate change, safety, and consumer as well as human rights. It considers the legal awareness in respect to several nocturnal risks by legal prospective, including in relation to environmental light pollution risks, and the legal actions that should be taken by environmental and local authorities to tackle all key elements of outdoor light pollution. If the Government aims to control all key aspects of non-environmentally friendly or inappropriate lighting, it must clarify how negative effects of light pollution should be minimised. Under the law, the regulatory standards must strike a balance between protecting the night environment and the use of outdoor light.

Light pollution problems have been increasing during the process of urban development because proliferation of artificial lighting usage generally contributes to the rapid growth of urban planning and public transportation. Urban sprawl lighting significantly makes outdoor living the most convenient way to get an equal or greater perception of visibility and increases the hours of usage for outdoor activities, for example, illumination of roads and hazardous areas, lighting for security reasons and lighting for appearance of commercial premises at night.

On the other hand, the increased use of lighting can cause a number of environmental issues. Inappropriate lighting in the wrong place at the wrong time can be intrusive or obtrusive. Likewise, inefficient lighting in either urban or rural developments can be artificial light pollution that is illuminating or polluting areas not intended to be lit. Light pollution can refer to inappropriate or non-environmentally friendly lighting which has many negative impacts to the environment.

Thus, light pollution should be considered to be non-environmentally friendly lighting which is not welcomed in the environment, e.g. an inappropriate amount of light, light causing glare, wasted light shining into the sky, or intrusive light. Poor lighting design or fixtures are the most ordinary causes of inefficient or polluting lighting system and this gives rise to the research questions. Therefore, this research is prepared to

investigate the areas of light pollution law by key debates and arguments. This research paper was to involve in many parts of this Chapter covering simplify the legal substance of the light pollution effects, separating main light pollution effects and presaging the future adverse effects. If the public sector and local authorities outline the benefits of implementing light pollution controls, they might meet their own environmental and planning targets as well as contribute to national targets on all light pollution adverse impacts.[49] Where a solution to the adverse effects is legally required, the prospective legislators should specifically provide the knowledge of all light pollution effects prior to the reform of the environmental and planning regimes for sustainable light pollution control.

The Chapter sets out the current context of light pollution impacts. It also critically analyses the legal problems associated with each adverse effect of light pollution before setting out the options for finally making recommendations concerning legal measures to reduce light pollution. This research is specifically concerned with leading the way on reforming or modernising legal regimes in England.

2.2 Light pollution and astronomy

Natural dark landscapes at night are preconditions for astronomical observations because night sky areas can offer significant benefits for both professional and amateur observatory environments.[50] Dark landscapes and low brightness areas, where the ability to see natural starlight not only preserves the visual links to the dark-sky heritage that have connected humankind throughout astronomical history[51], but also beneficially supports naked-eye observations or astronomical telescopes, which are devices used to observe the starlight.[52] However, light pollution is an increasing problem threatening

[49] Department for Environment, Food and Rural Affairs, *Defra position statement on Environmental Management Systems*, Department for Environment, Food and Rural Affairs, 2008, p 3.

[50] House of Commons Science and Technology Committee, *Light Pollution and Astronomy Seventh Report of Session 2002–03*, No HC 747-I, 2003, p 6.

[51] International Council on Monuments and Sites & International Astronomical Union, *Heritage Sites of Astronomy and Archeoastronomy in the Context of the UNESCO World Heritage Conservation: A Thematic Study*, 2010, p 6.

[52] Distant astronomical objects, galaxies as well as universes are too far away for us to reach. We may not directly go to them to study them. So everything astronomers and lawyers know about distant stars and

astronomical facilities because human-made lights shining into the sky generally increases the night sky brightness and inappropriately decreases the chance to start exploring the night sky.[53] For professional or amateur astronomers, trying to collect the faint light of distant objects, the urban atmospheric smog from outdoor lighting activity has become a significant astronomical problem[54] because it generally gets bounced up in to the atmosphere, causing the night sky to appear brighter and reducing the number of sky objects visible.[55] Therefore, many advances at the frontiers of astronomy require observations of very faint objects that can be studied only with advanced telescopes located at inherently dark landscapes, well away from urban atmospheric smog.[56]

The main reason for urban lighting usage is the result of two urbanisation growth factors, such as natural increase in population and migration to urban areas.[57] The most important causes of inappropriate lighting influences on astronomical observations are sky brightness or upward lighting emission that hang over urban zones at night. Even though industrialisation[58] and commercialisation[59] are central to economic growth and

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galaxies comes from analysing the radiation they produce. Many types of astronomical telescopes are devices used to generally observe the universe. See BBC, *How telescopes work*, available online from http://www.bbc.co.uk/schools/gcsebitesize/science/edexcel/visiblelight_solarsystem/telescopesrev3.shtml accessed 9 September 2013. and See also BBC, *Stargazing Live Telescope Guide*, BBC Learning, 2013, p 1-6, available online from http://downloads.bbc.co.uk/tv/stargazinglive/sgl_guide_to_telescopes.pdf accessed 9 September 2013.

[53] UNESCO World Heritage Centre, International Astronomical Union & Instituto de Astrofísica de Canarias, *Starlight Reserves and World Heritage scientific, cultural and environmental values*, International Workshop and Expert Meeting, Canary Islands, 10-11 March 2009, p 2.

[54] Fraknoi, A., *Dark Night Skies: Dealing with Light Pollution*, available online from http://www.astrosociety.org/wp-content/uploads/2013/07/5_16_Dark_Night_Sky.pdf accessed 9 September 2013.

[55] Caribbean Institute of Astronomy, *6 Benefits of doing Amateur Astronomy in the Caribbean*, available online from http://www.caribbeanastronomy.com/resources/6%20Benefits%20of%20doing%20Amateur%20Astronomy%20in%20the%20Caribbean.pdf accessed 9 September 2013.

[56] International Dark-Sky Association, *The Problem with Light Pollution*, available online from http://www.darksky.org/assets/documents/is001.pdf accessed 9 September 2013.

[57] Bhatta, B., *Analysis of Urban Growth and Sprawl from Remote Sensing Data in Geographic Information Science*, Springer-Verlag Berlin Heidelberg, 2010, pp 18-20.

[58] Hanel, A., 'Communicating Light Pollution in A Highly Industrialised Country – Germany', in Marin, C. And Jafar, J. (eds) *Starlight A Common Heritage*, Starlight Initiative Instituto de Astrofísica de Canarias (IAC), 2007, p 313-318.

[59] Wu, B. and Wong, H., *Visualization and Analysis of Light Pollution: A Case Study in Hong Kong*, ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Volume I-2,

improve prospects for human well-being as well as public services, the adverse results of industrial and commercial lighting growth have been accompanied by serious degradation of the dark-sky environment, as well as growing threats to human-beings from excessive and inappropriate lighting hazards. Furthermore, increased use of urban lighting has resulted in sky glow which has particular connections with astronomical observation problems, for example, direct upward light and upward reflected light from street lighting, security lighting, commercial advertising lighting, billboard lighting and decorative lighting.

2.3 Light pollution and ecology

Urban growth and density drive the spread of artificial light lighting, which in turn drives increased commercial sector and public infrastructure lighting use, all of which require this at night. The increase in the peripheral lighting zones of urban areas is generally accompanied by an even faster increase in urbanisation, industrialisation, commercialisation as well as public service. Lighting infrastructures from public or private premises are normally provided to develop the availability and, safety for, and access to a variety of night activities and integrating visibility convenience at night. This artificial light has many uses, but ultimately disturbs the ecological system.[60]

Light pollution from excessive or obtrusive lights causes habitat loss, habitat fragmentation, loss of biodiversity, loss of protected species, disturbance to ecosystems and risk to unprotected habitats.[61] The most common light pollution action is generally that excessive or obtrusive lights interfere with the natural timing of necessary biological activities or ecological cycles.[62] For example, the celestial compass obscured by urban light pollution for some nocturnal animals[63] and light pollution has profoundly

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Melbourne,25 August – 01 September 2012, p 173.

[60] Dick, R., *Guidelines for Outdoor Lighting in RASC Dark-sky Preserves and IDA Dark Sky Places (RASC-DSP-GOL, IDA-DSP-GOL)*, Royal Astronomical Society of Canada, 2008, p 12.

[61] Edwards, L. & Torcellini, P., *A Literature Review of the Effects of Natural Light on Building Occupants*, Colorado, 2002, National Renewable Energy Laboratory, p 5-6.

[62] Florida Atlantic University, *Light Pollution Harms the Environment*, available online from http://physics.fau.edu/observatory/lightpol-environ.html accessed 11 September 2013.

[63] Kyba, C.C.C., Ruhtz, T., Fuscher, J. & Holker, F, 'Lunar Skylight Polarization Signal Polluted by Urban Lighting', 2011 *Journal of Geophysical Research*, available from http://userpage.fu-

changed light conditions at night.[64]

The importance of appropriate lighting in the urban environment not only helps us feel safe and secure, but also makes a significant contribution to social cohesion and economic progress[65], however chronic or periodically increased illumination, unexpected changes in illumination, and light spillage from the urban growth as well as the rapid development of urban lighting have potentially adverse ecological impacts.[66]

2.4 Light pollution and human health

Light pollution is generally considered to cause significant harm to the health of human organisms or other interference with the human being. Many forms of light pollution are released into the environment. Causes of light pollution involve a number of actions that have been directly linked to excessive or obtrusive artificial light in the wrong location at the wrong time. Light pollution harm may be directly attributable to the effects of inappropriate light usages.[67]

The detrimental impacts of light pollution have been addressed by scientific evidence which serves to either support or counter a medical theory or health science hypothesis.[68] Light pollution is a major environmental risk to health and there is significant evidence for concluding that light pollution is associated with an increased

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berlin.de/~kyba/publications/skyglow_polarization.pdf accessed 11 September 2013.

[64] Patriarca, E. & Debernardi, P., *Bats and light pollution*, UNEP / EUROBATS Secretariat, 2010, p 2.

[65] Charnley, M. & Jarvis, T., *In the Shade: Lighting Local Urban Communities*, Helen Hamlyn Centre for Design, 2012, p 2.

[66] Ecological light pollution includes chronic or periodically increased illumination, unexpected changes in illumination, and direct glare. See Rich, C. and Longcore, T, 'Ecological Light Pollution', *Frontiers in Ecology and the Environment*, 2004, 2(4), pp 191-198.

[67] Section 1 of the Environmental Protection Act 1990 defines '*pollution of the environment*' as '*pollution of the environment due to the release (into any environmental medium) from any process of substances which are capable of causing harm to man or any other living organisms supported by the environment*'. Additionally, '*harm*' is defined as '*harm to the health of living organisms or other interference with the ecological systems of which they form part, and in the case of man, includes harm to his property*'. So, legal definitions of '*pollution of the environment*' and '*harm*' might help to decide the level of light pollution protection afforded to people's health and the environment. Nevertheless, the current English provisions do not specifically explain that it recognises that human health problems can be caused by the detrimental impacts of inappropriate lighting.

[68] Chepesiuk, R., 'Missing the Dark: Health Effects of Light Pollution', *Environmental Health Perspectives*, 2009 117 (1), pp 20-27.

risk of human health. Excessive or intrusive lighting from urbanisation with more environmental disturbance is able to disrupt human health.[69] For example, circadian rhythms at the inappropriate time of day that are wrong physical, mental and behavioural changes that follow a roughly 24-hour cycle, responding wrongfully to non-environmentally friendly light in an organism's environment[70], biological clock at the inappropriate time of day that is any wrong cyclic change in the level of a bodily chemical or function[71], decreasing levels of nighttime melatonin that may be associated with women's breast cancer risk[72], and glare on transportation safety.[73]

However, in determining the appropriate way to control light pollution effects on human health, a critical question must be answered. Why should the law be involved?

Light pollution started to become a health problem around the time urban development began adopting artificial lighting in several jurisdictions and their lighting governing bodies officially provided information that promoted the precaution and prevention of unnecessary or inappropriate lighting in terms of health, safety and well-being, and the non-environmentally friendly lighting practice of the built and natural environment.[74]

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[69] International Dark-Sky Association, *Light Pollution and Human Health*, International Dark-Sky Association, 2009, pp 1-2.

[70] National Institute of General Medical Sciences, *Circadian Rhythms Fact Sheet*, available from http://www.nigms.nih.gov/Education/Factsheet_CircadianRhythms.htm accessed 02 October 2013. and See Lockley, S. W., 'Circadian Rhythms: Influence of Light in Humans', 2009 (2) *Encyclopedia of Neuroscience*, available from http://www.energyperformance.net/pdfs/Circadian-Rhythms-Influence-of-Light.pdf accessed 02 October 2013.

[71] Hedge, A, *Biological Rhythms DEA 3250/6510*, available from http://ergo.human.cornell.edu/studentdownloads/DEA3250pdfs/biorhythms.pdf accessed 02 October 2013.

[72] University of Maryland Medical Centre, *Melatonin*, available from http://umm.edu/health/medical/altmed/supplement/melatonin accessed 02 October 2013. and See Arendt, J., 'Melatonin, circadian rhythms and sleep', *New England Journal of Medicine*, 2000 343(15), pp 1114-1116. and Lewy, A. J., Emens, J., Jackman, A., Yuhas, K., 'Circadian uses of melatonin in humans'. *Chronobiology International*, 2006 23 (1-2) , pp 403-412.

[73] National Highway Traffic Safety Administration, *Glare from Headlamps and other Front Mounted Lamps Federal Motor Vehicle Safety Standard No. 108; Lamps, Reflective Devices, and Associated Equipment*, Department of Transportation RIN 2127-AH81, 2001, available from http://www.nhtsa.gov/cars/rules/rulings/glare.html accessed 03 October 2013.

[74] For example, the Campaign for Dark Sky (CfDS) has officially released a brief detail explaining various medical concerns related to light pollution. The CfDS stringently stated that '*There is now significant evidence showing that exposure to light at night can disrupt the body's production of*

This means the law is able to empower environmental agencies and local authorities to deal with light pollution from outdoor light premises when they highlight some of the key risks which may exist and examples of the sustainable, precautionary and preventive measures which could be taken. The following reasons may be why the law should involve a wide array of environmental public interest concerns and legal techniques for dealing with non-environmentally friendly light.

For example, the law is able to address the relationship between scientific advice and evidence and the classification of a specific level of outdoor light to each acceptable or unacceptable lighting condition, to make it easier for people to understand clearly whether light pollution is reaching unhealthy levels in their local areas. Each outdoor lighting condition can also correspond to a different level of health concern. With respect to the classification of a specific level of outdoor light, the law may identify measurable anomalies in the classification of unhealthy levels for sensitive groups and unhealthy levels for everyone.[75] This may include the advice from people and practitioners within the light pollution field upon whom the classification of a specific level of outdoor light has a direct impact.

Of course, in English legal system, some types of light pollution can currently be designated a statutory nuisance if they are proved to be prejudicial to health or a nuisance under the *Environmental Protection Act 1990* and the *Clean Neighbourhoods and Environment Act 2005*. The current statutory nuisance encompasses a specific form of artificial light nuisance in order to ensure that people may live and work in environmentally friendly lighting conditions within the lighting governance.

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melatonin, a brain hormone best known for its daily role in resetting the body's biological clock. Secreted primarily in the brain, and at night, melatonin triggers a host of biochemical activities, including a nocturnal reduction in the body's production of oestrogen. Research has shown that decreasing nocturnal melatonin production increases an individual's risk of developing oestrogen-related malignancies, such as breast cancer' See British Astronomical Association Campaign for Dark Sky, *Medical Problems*, available from http://www.britastro.org/dark-skies/health.html accessed 02 October 2013.

[75] In the same way as outlined above, the U.S. Clean Air legislation tells people how clean or polluted local air is, and what associated health effects might be a concern for local people. It sets a specific level to each Air Quality Index (AQI) category to make it easier for local people to understand quickly whether air pollution is reaching unhealthy levels in their localities. See AirNow, *Air Quality Index (AQI) Basics*, available from http://airnow.gov/index.cfm?action=aqibasics.aqi accessed 03 October 2013.

Although statutory nuisance from artificial light under s79 (1) of the *Environmental Protection Act 1990* is clearly stated as '*artificial light emitted from a premises so as to be prejudicial to health or a nuisance*' and the specific term *'prejudicial to health*' is defined in the 1990 Act as *'injurious, or likely to cause injury, to health*', determination of what in fact are conditions prejudicial to health is not more a judgement based upon some types of light pollution,[76] for example, urban sky glow or atmospheric smog that hangs over town and cities at night.

Not only glare and light intrusiveness, but also lighting shining directly upward into atmospheric areas, is able to cause adverse effects on health and well being. A growing body of evidence links the brightening night sky directly to measurable negative impacts on human health and immune function and on a decrease of both ambient quality and safety in our nighttime environment,[77] for example, excessive blue-rich light scattering in the atmosphere can cause more eyestrain[78] and the rapidly expanding use of bluish-white outdoor lighting threatens visibility at night.[79]

However, the English provisions do not cover all lighting conditions as well as situations and the current legislative frameworks do not set targets and long-term objectives for concentrations in all aspects of light pollution. Consequently, health effects, health costs and other health financial matters are definitely caused by light pollution. If the law fails to meet normal lighting standards or requirements, light pollution might interfere with health and human well-being. For example, failure of light pollution control would affect the public healthcare system and private insurer spending on hospital admissions as a result of light pollution causes.[80]

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[76] Morgan - Taylor, M., 'Light Pollution and Nuisance: The Enforcement Guidance for Light as a Statutory Nuisance', 2006 August, *Journal of Planning & Environmental La*w, available from http://www.britastro.org/dark-skies/pdfs/JPEL2006_08.pdf accessed 03 October 2013.

[77] Dark Skies Awareness, *Light pollution—what is it and why is it important to know?*, available from http://www.darkskiesawareness.org/faq-what-is-lp.php accessed 03 October 2013.

[78] Owen, B.. 'IDA Says boo to blue light', 2009 October, *LED Magazine*, available from http://ledsmagazine.com/news/6/10/8 accessed 03 October 2013.

[79] International Dark-Sky Association, 'IDA Press Release: Blue light threatens animals and people', 2009 (10), *International Dark-Sky Association Night Watch*, available from http://www.enn.com/press_releases/3112/print accessed 03 October 2013.

[80] However, individuals concerned with light pollution problems and planning development must use a

As with effects of light pollution on human well-being, the legal problem is that the current English laws do not make consistent links between all aspects of light pollution control and human health. If some aspects of light pollution have occurred and there is no legal defence, the Government and environmental authorities might prepare a specific legal framework where they consider this necessary for the protection of the human health and well being.

Therefore, lighting installation and design should be environmentally designed to minimise interference with normal circadian rhythms in dark landscapes as well as brighter areas. It may be the duty of each authority to ensure that the actions made by the authority and other stakeholders for lighting practices are adequate for the purpose of light pollution control and an awareness of legislative options and a commitment to participate in national or local opportunities.[81]

Furthermore, many medical studies[82] investigating the relationship between light pollution and medical causes showed that inappropriate or excessive light emission were associated with increases in human health problems. For example, the American Medical Association (AMA) has released a medical report explaining various medical concerns related to intrusive light at night. The AMA powerfully stated that:[83]

'*the natural 24-hour cycle of light and dark helps maintain precise alignment of circadian biological rhythms, the general activation of the central nervous system and*

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good deal of judgement to weigh the relatively tangible costs of the various modes against a number of lighting considerations not easily quantified in health costs. See Small, K, A. ' Estimating the Air Pollution Costs of Transport Modes', 1977 May *Journal of Transport Economics and Policy*, available from http://www.bath.ac.uk/e-journals/jtep/pdf/Volume_X1_No_2_109-132.pdf accessed 07 October 2013. accessed 07 October 2013.

[81] Morris J. Wosk Centre for Dialogue, *Summary Document from the Clean Areas and Prevention of Significant Deterioration Workshop*, Simon Fraser University, Vancouver, 2004, p 21.

[82] Many medical studies have strongly suggested that the modern practice of keeping our bodies exposed to light pollution, increases cancer risk, especially for breast cancers that require hormones to grow. Women who work night shifts have shown higher rates of breast cancer, whereas blind women, who are not likely to be exposed to or perceive light pollution, have shown decreased risks. See Spivey, A., 'LIGHT POLLUTION: Light at Night and Breast Cancer Risk Worldwide', Environmental Health Perspectives, 2010 118 (12), p 523.

[83] American Medical Association, *Report 4 of the Council on Science and Public Health (A-12) Light Pollution: Adverse Health Effects of Nighttime Lighting, American Medical Association*, 2012, pp 1-2.

various biological and cellular processes, and entrainment of melatonin release from the pineal gland. Pervasive use of nighttime lighting disrupts these endogenous processes and creates potentially harmful health effects and/or hazardous situations with varying degrees of harm. The latter includes the generation of glare from roadway, property, and other artificial lighting sources that can create unsafe driving conditions, especially for older drivers. More direct health effects of nighttime lighting may be attributable to disruption of the sleep-wake cycle and suppression of melatonin release. Even low intensity nighttime light has the capability of suppressing melatonin release. In various laboratory models of cancer, melatonin serves as a circulating anticancer signal and suppresses tumor growth. Limited epidemiological studies support the hypothesis that nighttime lighting and/or repetitive disruption of circadian rhythms increases cancer risk; most attention in this arena has been devoted to breast cancer. Further information is required to evaluate the relative role of sleep versus the period of darkness in certain diseases or on mediators of certain chronic diseases or conditions including obesity. Due to the nearly ubiquitous exposure to light at inappropriate times relative to endogenous circadian rhythms, a need exists for further multidisciplinary research on occupational and environmental exposure to light-at-night, the risk of cancer, and effects on various chronic diseases.'

Light pollution as a new health risk may be mitigated or adapted by the requirements for lighting as well as special requirements for healthy residential environments. This means the law may make people minimise and prevent light pollution in conservative dark landscapes and urban brightness areas because the conserved dark landscape or dedicated dark landscape is able to be controlled to prevent any non-environmentally friendly light to be directed at oncoming human well-being in such inappropriate brilliance as to imbalance the 24-hour day-night cycle.

The light pollution impacts on human health also bring into focus the question of the role of measurable metrics and acceptable degrees in regulatory requirements, both in environmentally friendly light conditions and between lower and upper acceptable light values. The relationship between measurable metrics and acceptable degrees means that factors that affect the level of light pollution control, such as the obtrusive light

limitations for exterior lighting installations and the measurable metrics of acceptable healthy night environment, may be regulated as part of advice about the minimisation of outdoor light activities that inappropriately lead to light pollution impacts on human health.

As mentioned previously, for a health risk assessment, bearing in mind the scientific evidence for human health and the consistency between certain cancers observed in humans (in particular breast cancer), it is prudent to consider the unacceptable levels of outdoor light pollutants (in particular, levels exceeding the levels of health concern) associated with both brightness and directions of outdoor lights.[84] So, all legal aspects of light pollution should be fit for all public health purposes and should be replaced with a more scientifically-based scale of harm.[85]

2.5 Light pollution, energy and climate change

The electric lamp has many essential uses, including illumination of transportation areas, security lighting, to increase the hours of usage for outdoor facilities and to enhance the appearance of buildings at night. Additionally, artificial light from electric lamps allows people to extend daytime activities into the night and gives an attribute of visual perception where the need for adequate brightness is necessary. However, excessive or intrusive artificial light in the wrong place at the wrong time can be a waste of energy and money[86] and energy wasting due to non-environmentally friendly lighting design can cause carbon dioxide emissions and global warming.[87] The International Dark-Sky Association (IDA) estimates that billions of dollars are spent on unnecessary lighting every year in the United States alone, with over $2.2 billion going directly into the night sky via non-environmentally friendly lights.[88] Similarly, the British

[84] World Health Organization, *WHO guidelines for indoor air quality: selected pollutants*, World Health Organization, 2010, p xxii.
[85] Beijing Air Pollution, *Beijing Air Pollution: Real-time Air Quality Index (AQI)*, available from http://aqicn.org/city/beijing/ accessed 07 October 2013.
[86] Alberta Dark Sky Association, *Light Pollution – Energy Production and Air Pollution*, Alberta Dark Sky Association, 2008, pp 1-2.
[87] Khorram, A., Yusefi, M. and Keykha, S., 'Light Pollution, a World Problem', *Health Scope*, 2014 3 (4), pp 1-2.
[88] International Dark-Sky Association, *PG 1: Introduction to Light Pollution IDA Practical Guide*,

Astronomical Association's Campaign for Dark Skies (CfDS) estimates that there are 7.5 million street lights in the UK, with a mean power of 100W (Institution of Lighting Professionals (ILE)'s figures), that typically lose 15% of their direct upward light, above the horizontal. Up to a further 15% of light spillage is emitted where it is not wanted.[89]

Light pollution can be increasingly linked to economics concerned with environmental issues. There are a number of ways to use lights in many categories - residential, commercial, industrial, and transportation. The ability to maintain desired visibility and night landscapes are necessarily of the most important accomplishments of modern society, but many households in a time of light use may have a high consumption of electricity because they use excessive electricity to illuminate their home or increase human visibility with cost implications.

Light spillage from poor design or inefficient light fixtures, light trespass on surrounding properties and direct upward light are directly related to wasted energy, therefore carbon dioxide emissions with significant potential to increase atmospheric problems.[90]

The cumulative effects of excessive electricity use are an acceleration of climate change, and the inherent losses in electricity generation and transmission. So, light pollution associated with climate change and global warming is an environmental problem because unnecessary or obtrusive lighting will adversely affect a number of ecosystems that contribute to human well-being and energy economics that promote sustainable electricity consumption.

2.6 Light pollution and safety

Appropriate brightness[91] at the workplace can enhance workers' performance and

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International Dark-Sky Association, 2002, p3.

[89] British Astronomical Association, *The Environmental Cost*, available from http://www.britastro.org/dark-skies/environmental.html?4O . accessed 07 October 2013.

[90] Pottharst, M. & Könecke, B., '*The Night and Its Loss'* in Henckel, et al, '*in Space–Time Design of the Public City*', Springer's Urban and Landscape Perspectives, 2013, pp 37-48.

[91] The Workplace (Health, Safety and Welfare) Regulations 1992 requires employers to ensure that every

occupational safety. [92] However, light pollution becomes increasingly problematic threatening human safety because outdoor light pollutants are able to emit any light to be directed at oncoming necessary areas in such brilliance as to impair the visibility of any people and to be directed into any area zoned for quality of lighting in a workplace. In many cases it is clear that lighting incidents have high potential to impact many aspects of human safety, such as occupational health safety, transportation safety as well as community safety.

Many dangerous occurrences have a high potential to cause death or serious work injury[93] because poor quality lighting is able to increase occupational and safety hazards to workers by not indicating the visual presence of the objects and obstacles.[94] For example, all escape routes, including outside ones and exterior assembly areas, not having enough appropriate lighting to allow people to find their way out safely. Emergency escape and outdoor assembly point lighting may be needed in both interior and exterior lit areas or if the workplace is used at night.[95]

Inappropriate or excessive lighting from poor design or inefficient light fixtures can not only affect occupational health at work causing symptoms like eyestrain, migraine and headaches, but it is also linked to Sick Building Syndrome in new and refurbished buildings, for example, headaches, lethargy, irritability and poor concentration.[96] English law specially sets out the general duties to ensure that lighting is safe and does

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workplace must have suitable and sufficient lighting in the workplace. Appropriate brightness and directional luminaires from good lighting design and installation should normally be minimised to reduce discomfort glare and intrusive light. See UK Legislation, *Workplace (Health, Safety and Welfare) Regulations 1992*, available from http://www.legislation.gov.uk/uksi/1992/3004/contents/made accessed 20 January 2014.

[92] Zumtobel, *Light for Industry and Engineering*, Zumtobel, 2013, pp 1-60. available from http://www.zumtobel.com/PDB/Teaser/EN/AWB_Industrie.pdf accessed 20 January 2014.

[93] Poor lighting is generally an adverse factor in accidents and can also increase visual fatigue. See Health and Safety Executive, *Health and Safety in Engineering Workshops New Edition Including Guidance on Loler and Puwer 98*, Her Majesty's Stationery Office, 1999, p 9.

[94] OEGA BV, *Chapter 6. Visual Aids for Denoting Obstacles*, available from http://www.orga.nl/pdf/Chapter%206%20-%20Visual%20Aids%20for%20Denoting%20Obstacles.pdf accessed 20 January 2014.

[95] Health and Safety Works NI, *Health and safety information for small businesses*, Health and Safety Works NI, 2011, p 20.

[96] Health and Safety Executive, *Lighting at Work*, Stationary Office HSG 38, 1997, p1.

not pose a health risk to employees and others who may use their premises[97], but there are no specific minimum lighting requirements under the English legal system. Although the Chartered Institute of Building Services Engineers or CIBSE provides guidance for managing the health and safety risks from lighting in the indoor workplace and surrounding area, CIBSE's code of lighting practice does not have any legally binding force in English legal system.[98] In addition, English safety law establishes a duty on employers to assess potential risk from non-environmentally friendly design or inappropriate light fixtures. This includes risk from using lighting and electrical equipment in the workplace.[99] However, previous or current English safety frameworks do not impose specific requirements for the purpose of eliminating or reducing risk to safety from exterior lighting equipment, outdoor lighting product or other outdoor lighting properties in connection with work. This means that current English safety law has not become one of the prerequisites for light pollution control relating to work on outdoor workplace's premises.

Light pollution not only affects occupational health and work safety, but also transport or traffic safety. Excessive or intrusive lighting from motor vehicles, watercraft, aircraft and other transport facilities has resulted in transport safety problems. Inappropriate or non-standard lighting may dazzle or cause discomfort to other drivers, including pedestrians, cyclists and other road users.[100] Each method of transport may have a

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[97] Employers have a general duty under the Health and Safety at Work etc Act 1974 to ensure the health and safety of employees and others who may be affected by their work activities. See UK Legislation, *Health and Safety at Work etc. Act 1974*, available from http://www.legislation.gov.uk/ukpga/1974/37/contents accessed 20 January 2014.

[98] Slater, A. & Webber, G., *Energy Efficiency Standards for Lighting*, Building Research Establishment, 1993, pp 203-211.

[99] English safety law established a general duty on employers to comply with the Health and Safety (Display Screen Equipment) Regulations 1992 and the Provision and Use of Work Equipment Regulations 1998. These provisions apply in order to safeguard the use of lighting equipment as well as the lighting levels of indoor or outdoor display screen equipment, for example, computer screens, billboards and advertising banners. See UK Legislation, *Health and Safety (Display Screen Equipment) Regulations 1992*, available from http://www.legislation.gov.uk/uksi/1992/2792/contents/made accessed 20 January 2014 and See UK Legislation, *Provision and Use of Work Equipment Regulations 1998*, available from http://www.legislation.gov.uk/uksi/1998/2306/contents/made accessed 20 January 2014.

[100] Transport Department - The Government of the Hong Kong Special Administrative Region, *Bright Sunlight & Driving at Night*, available from http://www.td.gov.hk/en/road_safety/road_users_code/index/chapter_5_for_all_drivers/bright_sunlight_/i

fundamentally different lighting solution, for example, street lights, pedestrian crossing lights, traffic lights, vehicle headlamps, airport runway light and lighthouses are necessary for people's transportation.

There are a number of benefits to transport lighting and people need to ensure all transport lights are lit between sunset and sunrise or lit when visibility is seriously reduced by natural occurrence, but sources of non-environmentally-friendly-road-transport-light- technology can affect transport safety. The main elements of light pollution, such as discomfort glare, intrusive light and sky glow, generally disturb transport safety and harm health.

Because of lighting differences in each transport modes, the best approach was – for a specific impact on transport safety – to compare many forms of transport safety light pollution considered in that particular analysis. Firstly, for land transport or movement, the use of light is for safety such as that of light from passing vehicles.[101] For example, light from land transport safety sources such as street lights, vehicle headlamps, traffic signal lights, car park lights, railway lights and other land public transport station premises. The purpose behind lighting for land transport is to reduce the risk of traffic accidents through good design or installation of lighting, which is possible by using a land transport safety approach that takes due account of public or private safety concerns. Moreover, land transport lighting also has the potential to ensure visibility in the dark for drivers, motorists, cyclists and pedestrians.

Nevertheless, land transport lighting, allowed to illuminate or pollute areas not intended to be lit, may increase discomfort glare and intrusive light.[102] This can be caused when an inappropriate light angle[103], unnecessary shaded areas[104] or obtrusive light[105] is too

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ndex.html accessed 22 January 2014.

[101] Ward, R. et al, *Night-time accidents: A scoping study Report to The AA Motoring Trust and Rees Jeffreys Road Fund*, University College London Centre for Transport Studies & The AA Motoring Trust, 2005, p 6.

[102] Hickcox, K. S. et al, *Effect of different colored background lighting on LED discomfort glare perception*, Rensselaer Polytechnic Institute Lighting Research Center, 2012, available from http://www.lrc.rpi.edu/programs/solidstate/pdf/Sweater-SPIE8484-2012.pdf accessed 22 January 2014.

[103] Van Derlofske, J. et al, *Headlamp Parameters and Glare*, Rensselaer Polytechnic Institute Lighting Research Center, 2004, available from http://www.lrc.rpi.edu/programs/transportation/pdf/SAE/2004-01-

bright or unsuitably sited. Therefore, improved lighting quality of more energy-efficient streetlights results in better visibility through reduced glare, more even illumination, and enhanced colour rendering.[106]

The English legal system adopted a number of minimum standards of transportation lighting solutions, while even lowering the level of transportation lighting in some respects from the minimum requirements previously accepted by the current transport safety law. Many transportation safety frameworks have been keen to encourage more practical standards in lighting safety settings. For example, in the fields of vehicle lighting requirements and practices, drivers have to ensure that all headlamps are lit when visibility is generally, or seriously, reduced between half an hour after sunset and half an hour before sunrise, such as motorcyclists, cyclists and horse riders under the *Highway Code*[107] and the *Road Vehicles Lighting Regulations 1989*[108].

Moreover, in English jurisdiction, the Government and lighting governing bodies also provide requirements and standards in transport safety facilities to promote safety visibility[109] and foster energy efficiency[110]. For example, street lights as fixed lighting fixtures are intended to provide clear visibility to all drivers, motorcyclists, cyclists and horse riders during the hours of darkness to support transport safety and public safety[111],

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1280.pdf accessed 22 January 2014.

[104] City of Joondalup, *Streetlight Shading Policy City Policy*, City of Joondalup, 2010, pp 1-2.

[105] West Lothain Council, *Supplementary planning guidance: Controlling light pollution and reducing lighting energy consumption*, West Lothain Council, 2013, pp 1-22.

[106] Delaware Valley Regional Planning Commission, *Energy Efficient Traffic Signals & Streetlights*, Delaware Valley Regional Planning Commission, 2010, p 8.

[107] Government Digital Service, *The Highway Code: General rules, techniques and advice for all drivers and riders (103 to 158)*, available from https://www.gov.uk/general-rules-all-drivers-riders-103-to-158/lighting-requirements-113-to-116 accessed 23 January 2014.

[108] UK Legislation, *Road Vehicles Lighting Regulations 1989*, available from http://www.legislation.gov.uk/uksi/1989/1796/schedule/5/made accessed 23 January 2014.

[109] Department for Transport, *Traffic Signs Manual: Chapter 3 Regulatory Signs*, Her Majesty's Stationery Office, p 128.

[110] CSS Lighting Group & Mouchel, *CSS Street Lighting Project SL/22007 In vest to Save - Sustainable Street Lighting*, IHS, p 23.

[111] European Commission, *Street Lighting & Traffic Signals –Green Public Procurement Product Sheet, European Commission*, available from http://ec.europa.eu/environment/gpp/pdf/street_lighting_GPP_product_sheet.pdf accessed 23 January 2014.

complying with all relevant laws and frameworks, including the *Road Traffic Regulation Act 1984*, the *New Roads and Street Works Act 1991* and many lighting governing bodies' soft laws, such as *Codes of Street Light Practice, British Standards Specifications* as well as the *Institution of Electrical Engineers Regulations for Electrical Installations*.[112]

As mentioned above, these English lighting frameworks, which provide for best lighting practices in land transport safety, however, the goal of English lighting frameworks is not to set up good practices for both land transport safety and light pollution control which may allocate, reduce and eliminate risk opportunities for traffic accident and light pollution impacts. English frameworks, which are already in force, merely create responsibility for prevention of accidents; albeit excessive or obtrusive lighting from motor vehicles and land transport facility lights can also cause visual glare, sky glow as well as intrusive lights.

Similarly, in aviation safety, standardised airport lights and ground marking lights are used to identify aviation direction and increase aviation safety when takeoffs and landings are made by pilots as well as other aviation staffs. While air transport method is recognised as having one of the safest transport methods in the world, there is concern that emission of aviation lighting in the wrong place at the wrong time would have safety issues. Many international and national aviation regulatory bodies have responsibility for improving aviation safety towards airport lighting practices, e.g. taxiway lights, runway lights and airport beacon lights. However, airport facility lights from inappropriate and non-environmentally friendly fixtures and design can affect the beautification of the night sky around airport areas. This lighting may increase sky glow or light pollution dome[113] when lighting smog hangs over airports and surrounding areas at night.[114] Ecological systems and habitats around the airports may be affected by

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[112] Collins, T., *Street Lighting Installations for Lighting on New Residential Roads and Industrial Estates FINAL SPECIFICATION 27th June 2011*, Durham County Council, 2011, p 9-10.

[113] Abbott, C. J., *Proof of Evidence on behalf of the Campaign to Protect Rural Essex and Stop Stansted Expansion Landscape, Visual Impact and Quality of Life – No. SSE/18/a – Annex 1 Case Ref. 2032278*, BAA Ltd and Stansted Airport Ltd Doc., 2006, pp 1-5.

[114] O' Hanion Design Pty Ltd, *Appendix I Operational Lighting Impact Assessment*, O' Hanion Design Pty Ltd, 2013, p I-11-12.

sky glow[115], for example, bird migration and insect movement.[116]

Moreover, clutter of lights, which refers to obtrusiveness of light groups and may increase confusion from obstructions, intended to be illuminated, generally affects pilots' visibility during takeoff and landing at night. Dark sky landscapes and efficient airport lights may increase the safety environment at night. Nonetheless, light clutter from street light may decrease or eliminate the pilot's vision when the pilot needs to use the runway or heliport during night-landing operations.[117]

Light pollution also affects water transport safety. Ship or boaters may not find the shoreline because glaring lights and sky glow from waterside premises generally increase the difficulty of boating navigation. Glaring lights from the coast, which create background clutter and increase confusion that makes it difficult to see other boats, can partially blind sailors and contribute to boat crashes and boat accidents.[118] Similarly, sailors are not able to locate or navigate shoreline landmarks or coastline markers at night due to shoreline light pollution affecting visibility.

In English jurisdiction, the *Clean Neighbourhoods and Environment Act 2005* currently extends legal aspects of statutory nuisance to cover artificial light emitting from premises and interfering with someone's property or intruding upon areas not intended to be lit. Nevertheless, these provisions exclude some light sources for transport safety and security reasons from airports, railway and bus stations, goods vehicle depots, lighthouses, defence premises and prisons because outdoor light from these public service facilities can help people involved in public transport reduce the chances of accidents happening and prevent the threat of military or terrorist attacks around the UK. In terms of a general safety lighting approach, lights from all transport safety premises can shine outside the area it is intended to illuminate or produce

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[115] Aviation Environment Federation, *What are an airport impacts?*, available from http://www.aef.org.uk/uploads/PlanningGuide2.pdf accessed 23 January 2014.

[116] Civil Aviation Authority, *Large Flocking Birds: An Internal Conflict Between Conservation and Air Safety*, Civil Aviation Authority Safety Regulation Group, 2002, p 9.

[117] Schmidt, R. T., 'Reduce Risk of Inducing Spatial Disorientation Using Physiologically Compatible Ground Lighting' (1999) 70 (6), *Aviation, Space, and Environmental Medicine*, available from http://www.litebeams.com/pdf/spatialdisorientation.pdf accessed 23 January 2014.

[118] Thevenin, T., *Boating safety and light pollution*, University of Wisconsin-Milwaukee, 2013, pp 1-2.

uncomfortable brightness of light sources when viewed against darker backgrounds. So, lights from some light sources for transport safety and security reasons as mentioned above may produce several elements of light pollution when increased use of transport safety lighting has resulted in transport safety problems and human well-being.

A wide range of safety light sources can be used to increase levels of illumination used to protect communities. Effective lighting installations and design generally deliver adventage vision for security officers for combating crime and anti-social behaviour. Lighting at night can support visibility to protect our communities from serious crime matters, for example, terrorism and serious organised crime. Furthermore, in order to monitor crime, prevent opportunities for crime and identify crime matters, crime surveillance equipment is set up by security and safety bodies, nonetheless, light pollution from an inappropriate level of illumination or unwanted lighting direction may affect the effectiveness of crime surveillance devices.

For example, excessive brightness is able to reduce the clear exposure of closed-circuit television (CCTV) devices when poor design lighting from excessive glare does not effectively use crime surveillance equipment's features to increase the visibility of criminal behaviour. The visual ability to images of criminal behaviour images needs to be supported by the appropriate level of light or good light fixtures.[119] However, inappropriate light fixtures and design which could have many negative effects on opportunities for crime surveillance by interfering with policemen's security officers, and people's ability to monitor crime from the use of crime surveillance equipment in criminal investigations.[120]

The level of light will vary depending upon the security application. However, misdirected lights, light spill or excessive levels of light produces light pollution which occurs when the excessive illumination of lights against a dark background interferes with people's ability to view objects or landscape, i.e. over glare generally makes harsh

[119] City of Virginia Beach, *Crime Prevention Through Environmental Design: General Guidelines For Designing Safer Communities*, City of Virginia Beach Municipal Center, 2000, p 24.
[120] Association of Chief Police Officers and National Policing Improvement Agency, *Practice Advice on the Use of CCTV in Criminal Investigations*, Association of Chief Police Officers and National Policing Improvement Agency, 2011, p 48.

shadows which may even compromise the safety of community.[121] Therefore, the balance between necessary lighting and community safety should be concerned on the situation of wrong lighting practices and crime prevention whether the lighting benefits while eroding community safety should be avoided by the encouragement for good lighting practices, this still has an argument.

To maximise the potential to uncover crime, Crime Prevention Through Environmental Design (CPTED), as a principle of crime prevention, focuses on environmentally friendly design and the good practice of built environment management, which when applied, prevent both crime and environmental impacts.[122] CPTED design can lead to fear of crime[123] and crime observation[124], and to improvements in the community environment.[125] The use of good lighting design is considered to enhance the ability, safety and aesthetic appearance of outdoor landscapes is able to effectively support crime surveillance devices and appropriately provide good safety environment.[126] CPTED[127] not only reduces light pollution from premises for safety, since CPTED attempts to deter light pollution for improving performance of crime surveillance equipment, but it also maintains environmental quality.

So, whilst many aspects of the CPTED can support both light pollution control and

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[121] Florida Atlantic University, *Light Pollution Endangers Our Security and Our Safety*, available from http://physics.fau.edu/observatory/lightpol-security.html#GlarebombsNoSec accessed 30 January 2014.

[122] London Borough of Barking and Dagenham, *Planning Advice Note 6 Crime Prevention through Environmental Design*, London Borough of Barking and Dagenham, 2009, p 3.

[123] Nasar, J. L., Fisher, B. et al., 'Proximate physical cues to fear of crime' 2009, *Landscape and urban planning*. 26 (1-4), 161-178.

[124] Zahm, D., *Problem-Oriented Guides for Police Problem-Solving Tools Series Guide No. 8 Using Crime Prevention Through Environmental Design in Problem-Solving*, U.S. Department of Justice Community Oriented Policing Services, 2004, p 21.

[125] Crowe, T. D. and Zah, D. L., *Crime Prevention through Environmental Design*, National Association of Home Builders, 1994, p 22.

[126] Harrison, C. M., Limb, M., et al. 'Nature in the city: popular values for a living world' 1987, *Journal of Environmental Management*, (25): 347-362.

[127] Many researchers had concluded that lighting at night does not deter crime and the principal conclusion is that no evidence could be found to support the hypothesis that improved outdoor lighting can reduce reported crime. See Atkins,S., Husain, S. and Storey, A., *The Influence of Street Lighting on Crime and Fear of Crime*, Home Office Crime Prevention Unit, 1991, p viii. Furthermore, in Sussex, over glaring from outdoor lights is causing such poor crime surveillance quality that CCTV's cameras filmed criminals committing a crime who cannot be identified. See Town of Winchelsea, *Lighting & Crime*, available from http://www.winchelsea.net/images/lightandcrime.pdf accessed 30 January 2014.

crime prevention, it needs to be balanced against some of the other legal effects of CPTED adaption or implementation. The National Planning Policy Framework sets out a number of specific requirements for developing comprehensive policies which provide the quality of development that will be expected for the community areas. It recommends that the Government and local authorities should ensure that developments and land uses create community and accessible environments where crime and disorder, and the fear of crime, do not undermine quality of life or community cohesion.[128] Hence, this planning framework that relates to decision-making should be read as applying to the consideration of various aspects of CPTED, wherever this is appropriate given the relevant legislation. For example, the *Police and Justice Act 2006*[129] established a statutory duty on the police and local authorities to exercise their functions with the impacts on crime and disorder. It means that the government should promote CPTED to raise awareness broadly on environmental and crime issues through roles of the police and local authorities.

2.7 Lighting, Light pollution and human rights

Lighting is vital to all our lives and it is central to protecting the right to freedom of visibility of routes, objects and obstacles at night. It has a major role to play in promoting outdoor activities and enhancing safety and security at night. The right to freedom of outdoor lighting at night is also especially important to outdoor night-time activities and nightlife because of the basic need for safety and security and the general dynamics of business and commercial markets. These rights can give people the right to individual artificial lights and to enjoy their outdoor nightlife. However, this research has raised a few critical questions about how the right to freedom of outdoor lighting at night really is, in view of their increasing sustainably friendly environment and close integration with human rights awareness.

The relationship between a safe and healthy environment and the enjoyment of the right

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[128] Department for Communities and Local Government, *National Planning Policy Framework*, Department for Communities and Local Government, 2012, p 15.
[129] UK Legislation, *Police and Justice Act 2006*, available from http://www.legislation.gov.uk/ukpga/2006/48/contents accessed 30 January 2014.

to use their outdoor artificial lights has been introduced by the former United Nations Commission on Human Rights and the United Nations Human Rights Council.[130] Many international regulatory frameworks established a number of human rights that are particularly relevant to people's rights to enjoy lighting. In contrast, intrusive light is excessive brightness or inappropriately directed lights shining onto surrounding property which affects the neighbours' right to enjoy their property and a neighbours' right to enjoy their attainable standard of health.[131] The light pollution problems involve the conflict between a right to use the outdoor light and a right to a healthy environment. There is a conflict between the freedom of those who design their non-environmentally friendly or inappropriate outdoor lighting fixtures in order to meet their own individual, commercial and industrial purposes and the public interest of health and safety (including the right to a healthy environment and the health of others); the right to live in a healthy environment was. There may also be non-environmentally friendly lighting that occurs in a conflict situation. For example, the purpose of the use of new LED technology was to help localities and municipalities increase energy efficiency, save money, use renewable energy, and reduce reliance on fossil fuels. New LED light installations and design can help to reduce energy and maintenance cost, due to their inherent directionality.[132] However, the increased light emitted in the blue-rich and UV bands from street lights may cause further ecological damage due to the sensitivity of ecological and biological processes.[133] This means local or municipal people live their entire nocturnal life with the expectation that they will get environmentally friendly brightness and the appropriate level of light their localities or municipalities select, while some may be unaware that they have a fundamental human right to healthy

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[130] United Nations Environment Programme, *High Level Expert Meeting on the future of Human Rights and Environment: Moving the Global Agenda Forward*, available from http://www.unep.org/environmentalgovernance/Events/HumanRightsandEnvironment/tabid/2046/Default.aspx accessed 4 February 2014.

[131] World Health Organization, *The work of WHO on health and human rights*, available from http://www.who.int/hhr/teamflyer_eng_rev.pdf?ua=1 accessed 4 February 2014.

[132] New York State Energy Research and Development Authority, *Street Lighting in New York State: Opportunities and Challenges*, New York State Energy Research and Development Authority, 2015, p 8.

[133] Jägerbrand, A. K., *New Framework of Sustainable Indicators for Outdoor LED (Light Emitting Diodes) Lighting and SSL (Solid State Lighting)*, available from http://www.mdpi.com/2071-1050/7/1/1028/pdf accessed 4 February 2014.

environment.

Again, the conflicts of rights to enjoy lighting and rights to enjoy a good standard of human well-being have been raised by potentially increasing levels of lighting in urban landscapes. As mentioned above, excessive or inappropriate pollutants of lighting have known or suspected adverse impacts on human well-being. Many serious symptoms and conditions affecting human health comes from many components of light pollution, for example, light affecting where it is not intended, wanted, or needed and elevated brightness which causes visual discomfort. These problematic examples of light pollution impacts have not been resolved, because there are no real existing regulatory frameworks that have distinguished between the human rights, light pollution and human health. Human rights to health may be defined such that people have their rights to a living condition that ensures them to be environmentally healthy, such as adequate light use and healthy environment.

Outdoor lighting can contribute to make residents and street users feel safe and enhance the appearance of a transportation area at night.[134] However, excessive levels of illumination or inappropriate direction of lighting can invade the privacy of living areas and affect people's property and enjoyment of it, as well as disturbing sleep patterns. The key conflict of a right to sleep and a right to feel safe is also viewed as a situation in which light pollution occurs when light pollutants are emitted by outdoor premises where a number of levels and directions of outdoor light are needed for safety and security reasons. The result of lighting from non-environmentally friendly outdoor light fixtures and design can represents a specific failure to achieve the desired balance of rights to sleep and feeling safe in which rights are secured for individuals without the conflict of lighting interests. This research considers a number of circumstances of conflicts of rights in which the Government may attempt to solve, or be forced to solve, regulatory measures for balancing individual rights to sleep and feeling safe against relevant outdoor light pollution harms.

Although there has been increasing concerns over the adverse health impacts attributed

[134] Sansom, A., Bloxwich *Lighting PFI Residents Survey Spring and Autumn 2012 Summary of findings – FINAL*, Walsall Council, 2013, p 30.

to light pollution, a balance between the needs of lighting and environmental protection has not been recognised by legal decision-making. To ensure that the effects of light pollution are tackled effectively, the Government's regulators should give insight into how the law balances between the essential amount of light, the human well-being and environmental constraints in the real world. Additionally, they might consider how to shift the balance towards a greater standard and how to include human rights aspects of the essential standards in compliance with tackling light pollution.

Whereas it is essential to reduce the light pollution risk, the United Nation General Assembly states that the *Universal Declaration of Human Rights (UDHR),* as a common standard of achievement for all peoples and all nations defines that '*Everyone has the right to a standard of living adequate for the health and well-being of himself and of his family, including food, clothing, housing and medical care...*'. The philosophy of the UDNR is beginning to come to the wider attention of environmental governing bodies. When international environmental bodies consider some of the uncertainty and scientific ignorance about the harms of pollutants and the legal contexts in which they are assessed[135], it becomes clear why this research supported a similar approach to addressing such a right to healthy night environment needs to be applied by the legislatures and policy makers. Certain measurable levels of outdoor light pollution fall within the standard of living adequate for health and well-being, which may be a set of environmental and planning rules in each national and local jurisdiction. However, it has not been specified in the detail of light pollution control, and, of course, this is necessary to undergo a mixed rationality of the nocturnal environment and dark-sky protection based upon a number of measurable degrees of light pollution, especially with respect to necessary light and light pollution from typical outdoor luminaries.

Similarly, the Constitution of the World Health Organization (WHO), as a treaty to address the health consequences of human rights, also referred to the right to health or to elements of it in that '*The enjoyment of the highest attainable standard of health is*

[135] Cranor, C. F., 'Toward Understanding Aspects of the Precautionary Principle', 2004 (3) *Journal of Medicine and Philosophy*, available from http://www.glerl.noaa.gov/seagrant/ClimateChangeWhiteboard/Resources/Uncertainty/climatech/crannor04PR.pdf accessed 4 February 2014.

one of the fundamental rights of every human being...'. The philosophy under the WHO Constitution allows international and national jurisdictions apply to areas where the outdoor light is the greatest light polluter, as emissions from non-environmentally friendly outdoor lights at night. It also requires that the provision of such suitable or usable lighting metric in attainable lighting forms could be used to agree that the reliance degree of outdoor light is the most appropriate measure of outdoor lighting, and could be presented to the public to protect the right to health.

The human rights-based approach to health was regarded as a source of health rights under two international frameworks. These frameworks require many countries to support better and more sustainable health outcomes by analysing and addressing stakeholders' obligations and empowering rights-holders to claim their health rights.[136] Nonetheless, the problems that shape contemporary lighting practices are, on the one hand, the rights to the healthy night environment, and, on the other hand, the rights to use outdoor lights at night and the roles of local authorities when outdoor lights in wrong place at wrong time become pollutants. These leave unanswered a lot of arguments about the context of a human rights-based approach to necessary light use and a human rights-based approach to environmental health. For example, people have a fundamental right to a right to feel safe, that is free from criminal matters at night. Better street lighting will help to improve public transportation safety and reduce the fear of crime. Nevertheless light pollution from the intrusiveness of outdoor street lights at night is able to lead to sleep disorders and other relevant health issues. This means there is a conflict of human rights interest between a right to benefit from balancing the 24-hour length of the day and night and a right to feel safe at night. This conflict may be resolved in favour of the public environmental interest. Any conflict of environmental interest that arises should be avoided or resolved in the best interests of the dark-sky environment.

[136] World Health Organisation, *A human rights-based approach to health*, available from http://www.who.int/hhr/news/hrba_to_health2.pdf accessed 5 February 2014.

2.8 Light pollution, illuminating engineering and lighting architecture

Outdoor artificial light is essential for engineering and architecture, to illuminate landscapes and building façades. It is used to provide enhance the appearance of building façades and exterior landscapes. Urban areas in England have become the living point for people from different parts of the UK and the world. Outdoor lights generally support the visual ability of humans and they play many dominant roles within the contexts of illuminating engineering as well as lighting architecture.

Many techniques of illuminating engineering and lighting design are able to create positive lighting solutions for building façades.[137] The aesthetics of exterior light play an important role in the field of light design when artificial light at night in architectural spaces influences our experiences and feelings, our comfort and our physiological well-being.[138] For example, outdoor lighting designed without aesthetic consideration is able to adversely affect the night time appearance of outdoor premises.[139]

Lighting solutions for building façades facilitate orientation, advertise commercial services, control emotions, create attention and add economic value[140] by making the location more beautiful.[141] If the lighting is not done to accentuate an architectural element of the building, artificial lighting may not serve an architectural aesthetic purpose.[142]

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[137] Chartered Institution of Building Services Engineers, *Cross-Cultural Differences in the Perception of Façade Lighting*, available from http://www.cibse.org/content/SLL/Papakammenou%20Paper.pdf accessed 5 February 2014.

[138]Norwegian University of Science and Technology, *Nordic Light and Colours 2015*, available from http://www.ntnu.edu/documents/139701/18553665/NORDIC+LIGHT+AND+COLOUR+2015_program_03+10+2014.pdf/b3c6ea23-94be-4d2f-b97e-f6af099b2e96 accessed 5 February 2014.

[139] City of Westminster, *Lighting up the City*, available from http://transact.westminster.gov.uk/spgs/publications/Lighting%20up%20the%20City.pdf accessed 5 February 2014.

[140] Careless lighting fixtures and design may indicate lack of attention to detail. Characteristics of a poor indoor lighting design were: for example, hot spot light obscuring the true colours of ceiling mosaic, misfocused lights intruding in historical rooms and cheap contemporary fixture stuck into Victorian medallion. Kay, G. N., *Fiber Optics in Architectural Lighting: Methods, Design and Applications*, McGraw-Hill Professional, 1998, pp 76-77.

[141] Turner, J., *Lighting: an introduction to light, lighting and light use*, B.T. Batsford, 1994, p 17-25.

[142] Maine State Planning Office, *Promoting Quality Outdoor Lighting*, available from

The selection of luminaires and lamps as architectural lighting practices will help maintain a consistent exterior aesthetic[143] across the built environment where added social and economic value can be demonstrated, but this does not mean all architectural lights will not shine onto a neighbouring property without their permission or shine into atmospheric areas. Choice in the exterior aesthetic is generally driven by consumer preferences for architectural lighting design rather than by architects and light designers because consumers have the right to be assured that a selection of exterior light design services are available for them to purchase at competitive prices and they may expect a reasonable response to their specific needs for architectural aesthetic purposes.[144]

By contrast, this research argues that it would be too uncertain to introduce architectural light pollution specifically for all architectural aesthetic purposes. It would not be easy to define, and it would critically represent the mixed problems of light pollution and architecture, i.e. reducing building energy demand by incorporating energy efficient lighting and environmentally friendly light design[145] is specific to controlling unnecessary or inefficient lighting to reduce light pollution in the build environment, but consumers are able to select from a range of outdoor light design services, offered at competitive prices, that satisfy their needs for an architectural aesthetic purpose.[146]

Although maintained values of lighting are most effectively designed based on the levels of light and the directions of light required by the tasks performed within each building space[147], a lack of the performance improvements on some lighting activities may lead to some issues of light pollution.[148] Many possibilities for providing efficient

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https://www1.maine.gov/dacf/municipalplanning/docs/lightingmanual.pdf accessed 5 February 2014.

[143] California State University Office of the Chancellor, *Outdoor Lighting Design Guide*, California State University, 2008, pp 9-10.

[144] Alabama Cooperative Extension System, *Get to Know Your Basic Consumer Rights: How Do They Work for You?*, Alabama A&M and Auburn Universities, 2008, pp 1-2.

[145] University of Plymouth, *Sustainability Design Brief*, available from http://www6.plymouth.ac.uk/files/extranet/docs/SCE/University%20sustainability%20design%20brief.pdf accessed 5 February 2014.

[146] Northern Territory Consumer Affairs, Your rights as a consumer, available from http://www.consumeraffairs.nt.gov.au/ForConsumers/ConsumerRights/Documents/your_rights_as_a_consumer.pdf accessed 5 February 2014.

[147] Prichard, D. C., *Lighting*, Longman Scientific & Technical, 1995, pp 121-122.

[148] Newsham, G. et al., *Task lighting effects on office worker satisfaction and performance, and energy*

lighting to tackle issues of light pollution may be needed to set a flagship for the use of effective approaches to address good practices of illuminating engineering and lighting architecture without compromising, and indeed improving on, environmental effectiveness because consumers also have the right to live and work in a healthy night environment which is nonthreatening to the well being of present and future generations.[149]

Meanwhile, light pollution problems may cause enormous confusion to engineers and architects because of the rather complex interaction between environmental target and commercial target. The professional bodies of illuminating engineering and lighting architecture perhaps should highlight the financial benefits of professional lighting practices and sustainable lighting activities together with the need to improve how we protect the night environment and how a building will look at night.[150] Likewise, taking account of the needs of customers' lighting requirements and the desire to minimise adverse impacts from light pollution on the night environment, professional practices of light installation and design may not involve several associated light pollution problems in responsible manner of engineers and architects.

Illuminating technology has been rapidly changing and expanding in many lighting fields. Innovation in lighting technology is able to add a number of dimensions to life quality. Increasing interest in new technological lighting developments is relatively high but there are differences of the purpose of light uses.[151] However, innovative light uses and lighting electricity consumption have become many side effects of our night environment as well as nocturnal ecosystems[152], including carbon dioxide emissions.[153]

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efficiency, National Research Council Canada, 2005, p 1.

[149] Consumers Health Forum of Australia, *Charter of Health Consumer Rights*, available from https://www.chf.org.au/pdfs/fac/fac-charter-of-health-consumer-rights.pdf accessed 5 February 2014.

[150] Philips, D., *Lighting Historical Buildings*, McGraw-Hill Professional Publishing, 1997, p 169.

[151] European Commission, *Science and Technology Report January 2010 – February 2010*, Eurobarometer European Commission, 2010, p 8.

[152] The most innovative lighting technology emerging on the market is Solid State Lighting (SSL). It generally sets high quality innovation of lighting, while providing substantial cost saving opportunities, reducing light pollution in urban development and driving innovative technology in the lighting and construction sectors. Accordingly, when combined with intelligent lighting control, SSL can successfully save up to 70 % of electricity used for lighting and reduce energy and maintenance costs compared to

Many lighting governing bodies highlighted that there are illuminating engineering standards that relate to both the professional and practical, and that it is essential to avoid non-environmentally friendly lighting when light practitioners and consumers use their lights for industrial, commercial and household reasons. These standards are also considered in terms of a number of dimensions of illuminating engineering including metrics and degrees of outdoor light pollution.[154] When development of illuminating engineering technology has achieved environmentally friendly or energy efficient success in reducing key elements of outdoor light pollution, this has drawn upon the preventive approaches by increases in some metrics and degrees and growth in the number of environmental areas for outdoor lighting control.[155] This research accepts the lighting governing bodies' standards as soft law in principle, but questions how this would work in practice and what metrics and degrees of outdoor light pollution there would be.

Many illuminating engineering bodies are internationally and nationally committed to ensuring that their outdoor lighting standards have the appropriate metrics and specific degrees to take light pollution control action in support of outdoor light practitioners and are therefore taking forward the International System of Units (SI) of illuminance and luminous emittance.[156] For example, obtrusive light limitations for outdoor lighting fixtures are described in the *Institution of Lighting Engineers' Guidance Notes for the Reduction of Obtrusive Light*, contained in part of the design guidance, which explain the appropriate SI metrics and specific degrees of light pollution control.[157] These

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current lighting fixtures. See European Commission, *Lighting the Cities: Accelerating the Deployment of Innovative Lighting in European Cities*, European Commission, 2013, p7.

[153] The global carbon dioxide emissions from the use of electric lighting are already three times greater than those from the entire aviation sector. See Parliamentary Office of Science and Technology, *Postnote January 2010 Number 351 Lighting Technology*, Parliamentary Office of Science and Technology, 2010, p 1.

[154] Hollan, J., *What is light pollution, and how do we quantify it?*, available from http://amper.ped.muni.cz/light/lp_what_is.pdf accessed 5 February 2014.

[155] McCawley, M., *Air, Noise, and Light Monitoring Results For Assessing Environmental Impacts of Horizontal Gas Well Drilling Operations (ETD-10 Project)*, West Virginia Department of Environmental Protection Division of Air Quality, 2013, pp 14-15.

[156] Butcher, K., Crown, L. and Gentry, E., *The International System of Units (SI) –Conversion Factors for General Use NIST Special Publication 1038*, National Institute of Standards and Technology, 2006, p 14.

[157] North Yorkshire County Council, *Requirements for Planning Applications for floodlighting*, available

metrics, set out in this guidance, are mainly focused on environmental lighting areas, the upward light ratio of the installation, intrusiveness of light (lux), the source of light intensity (kcd) as well as building luminance (cd/m2). Specific metrics relevant to the time after which stricter requirements for the control of obtrusive light, such as periods of pre-curfew and post-curfew, will need to be used as alternatives if these are used to inform light industries, light practitioners and light consumers about the scale of the impact of light pollution on the night environment.

However, this research strongly argues that certain SI unit standards for environmentally friendly illuminance and energy efficient luminous emittance[158] were unlikely to fulfil all dimensions of light pollution control, and in fact could cause social and economic harms, in particular by encouraging illuminating engineers or light practitioners to allocate the economic and social losses associated with excessive or obtrusive lighting at night, such as those caused by nocturnal disturbance, human-being impacts, workplace distraction and diminished educational performance are not well researched in terms of all degrees of light pollution, with no agreed methodology in place. For example, none of the illuminating engineering metrics and the urban planning areas for outdoor lighting development that are currently used for environmental light pollution annoyance incorporate measures of harmful light pollution and house-based educational activities in high district brightness areas together, especially when urban light pollution interferes with a child's indoor and outdoor activities, such as sleeping, diminishes or disrupts a child's health or quality of night life. By way of example, this research highlights a number of wide approaches that would accept and plan for all degrees of light pollution measurement in outstanding dark landscapes and district brightness areas, and seek to find the sustainable balance for emission of light pollutants into the atmosphere, urban landscapes, or neighbourhood areas through the use of outdoor lights, for example, of a coordinated permit at the appropriate level of brightness.

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from http://m.northyorks.gov.uk/CHttpHandler.ashx?id=13048&p=0 accessed 5 February 2014.

[158] Haim, A. and Portnov, B. A., *Light Pollution as a New Risk Factor for Human Breast and Prostate Cancers*, Springer, 2013, p 11.

Furthermore, the adoption of new lighting technologies generally offers significant opportunities for meeting energy efficiency opportunities. For example, light-emitting diodes (LEDs) are an energy-efficient technology whose application to general purpose lighting is rapidly growing with a significant effect for energy savings and LEDs lighting devices are more durable than incandescent lights.[159] The widespread use of them could save electricity consumption and decrease carbon dioxide emission[160], but the effect of LEDs radiation at wavelengths shorter than 500 nanometres (nm) has a greater tendency to impact human organisms through disruption of their biological systems that rely upon essential cycles of light and dark,[161] for example, human vision and health effects. So, there is a question as to whether the correlation between the degree of human annoyance felt and the number of different wavelengths from sources of LEDs light emitted, including that blue-rich white outdoor light wavelength emission[162] could be considered an appropriate indicator of harmful wavelength impacts. The harmful light wavelength may arise because measurements of environmental sensitiveness have been ignored or because of wavelength amount matters outside the regulatory approaches, but the impacts on the night environment are concerned.[163] What is significant is to being able to identify a harmful light wavelength matter and stop or mitigate its adverse impact. It may be possible to anticipate such nocturnal harm through regulatory approaches by, for example, requiring environmental

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[159] Gereffi, G., et al., *Chapter 1: LED Lighting*, Center on Globalization Governance & Competitiveness, 2008, p 10.

[160] Contribution to climate change goals is able to be mentioned as co-benefits. See Valentová, M., Quicheron, M. and Bertoldi, P., *Joint Research Centre Science and Policy Reports: LED Projects and Economic Test Cases in Europe*, European Commission, 2012, available from http://iet.jrc.ec.europa.eu/energyefficiency/sites/energyefficiency/files/led-test-cases-report.pdf accessed 11 February 2014.

[161] International Dark-Sky Association, *Visibility, Environmental, and Astronomical Issues Associated with Blue-Rich White Outdoor Lighting*, International Dark-Sky Association, 2010, available from http://www.darksky.org/assets/documents/Reports/IDA-Blue-Rich-Light-White-Paper.pdf accessed 11 February 2014.

[162] Chen, E., *Seeing Blue*, available from http://www.darksky.org/assets/documents/SeeingBlue.pdf accessed 06 February 2015.

[163] David, A., Krames, M. R. and Houser, K. W., *Whiteness metric for light sources of arbitrary color temperatures: proposal and application to light-emitting-diodes*, available from http://www.soraa.com/public/docs/Whiteness-for-sources-of-arbitrary-CCT-David-Opt-Expr-21-2013.pdf accessed 06 February 2015.

governing bodies and authorities to adopt a regulatory indicator of harmful wavelength impacts that will allow it to be more easily seen as non-environmentally friendly or an inappropriate wavelength amount.

Again, a number of illuminating engineering metrics as analysed above are significant bearing in mind that the key question is whether the degrees of unacceptable or acceptable outdoor lights are inextricably linked to the key metrics of illuminating engineering, whether the relevant contexts of outdoor lighting are central to the light pollution measurements and to what extent the environmental governing bodies and authorities are likely to determine the control of light pollution. This research provides a few examples of illuminating engineering metrics which may link to the possible control of harmful lighting as used in various commercial and household activities. An environmental appraisal of the measurable metrics is necessary to ascertain the necessary degrees of outdoor light use. There is, however, concern that the absence of such checks in illuminating engineering measurements and outdoor lighting practices may lead to light pollution control being taken without due regard to all impacts on well being and the night environment. For example, if planning authorities attempt to distinguish between environmentally friendly electronic displays (i.e. digital electronic billboards) is permitted and some degrees of periodic lighting modulation or flicker is to be taken into account, planning permission may require the presentation of flicker physiology[164], which identifies key elements flickers that are exposed to stressful levels of light at night[165], such as frequency of the light modulation, amplitude of the light modulation, average illumination intensity, wavelength, position on the retina at which stimulation occurs and degree of light or dark adaptation.[166] In addition, the flicker

[164] Flicker is generally associated with increased incidence of headaches and eyestrain. People may detect this oscillation directly; for others who do not perceive the flickering visually, there is evidence that the neurological system does pick it up, which may cause health problems. See Newsham, G.R., Veitch, J.A., Reinhart, C.F. and Sander, D.M., 'Lighting Design for Open-Plan Offices' 2004 (64) *Construction Technology Update*, available from http://www.nrc-cnrc.gc.ca/ctu-sc/files/doc/ctu-sc/ctu-n62_eng.pdf accessed 06 February 2015.

[165] Veitch, J.A. and McColl, S.L., 'Modulation of fluorescent light: Flicker rate and light source effects on visual performance and visual comfort', *Lighting Research and Technology* 1995 (4) 27, pp 243-256.

[166] CREE, *Flicker happens. But does it have to?*, available from http://www.cree.com/~/media/Files/Cree/LED%20Components%20and%20Modules/XLamp/White%20Papers/Flicker.pdf accessed 06 February 2015.

produced by electric light sources (i.e. LEDs or incandescent lights) not only affects quality of life[167], but it has been linked to noise pollution problems.[168] Audible noise on an AC distribution line directly creates additional (light) modulation on resistive (incandescent) load.[169] In other words, the amount of noise annoyance created by flicker is not just determined by the degree of unwanted sound and kind of noisy outdoor light equipments, but also by the context of the flickering metrics.

Illuminating engineering or lighting design is a fundamental principle of various codes of lighting practices enshrined in various soft laws and developed by professional lighting bodies. They generally express a preference and not a legal obligation that lighting practitioners should act, or should refrain from outdoor installation and design, in a specified lighting manner. Whilst engineers and architects generally provide professional services as identified in their contracts and always exercise such professional skill as provided by various international or national codes of the professional light practitioners, environmentally friendly lighting practices are not legally bound to ensure only engineers and architects in different jurisdictions are allowed to obtain legal obligation to confirm sustainable outdoor lighting enhanced the environmentally friendly night-time appearance of outdoor objects, creating a more sustainable lighting environment at night.[170] Again, there is no legal obligation to show how these approaches to developing sustainable lighting can be integrated with environmentally friendly outdoor lighting design and all relevant parties (i.e. light practitioners' clients, practitioners, and site occupiers) to maximise the benefits of an outdoor light pollution control approach. Illuminating engineering and lighting design may inevitably lead to conflict between the need for all relevant parties' outdoor light

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[167] Wilkins, A. J. and Roberts, J. E., ' 'Flicker can be perceived during saccades at frequencies in excess of 1 kHz' 2013 (45) *Lighting Research and Technology*, available from http://www.essex.ac.uk/psychology/overlays/2013-207.pdf accessed 06 February 2015.

[168] There is growing evidence that not only does flicker cause annoyance, stress and sleep disruption, it can also lead to some noise pollution problems. See U.S. Department of Energy, *Building Technologies Office Solid-State Lighting Technology Fact Sheet: Flicker*, U.S. Department of Energy, 2013, pp 1-4.

[169] Poplawski, M., *What You Need to Know about LED Flicker and Dimming*, U.S. Department of Energy, 2012, p 2.

[170] Society of Electrical and Electronics Engineers in Israel, *Architectural lighting: not yet dead*, available from http://www.seeei.org/CIE-Israel/Articles/Architectural%20lighting%20-%20not%20yet%20dead-ILP-OCRC.pdf accessed 11 February 2014.

practices and the public environmental interests when all elements of light pollution need to be controlled by all relevant pollutants. The regulators and policy makers may highlight the new innovation of lighting technology concerns in illuminating engineering and lighting design, in order to affect a balance between the advantages and limitations of lighting technology as a way of addressing legal requirements in the future.

Chapter 3: Causes of Light Pollution

3.1 Introduction to causes of light pollution

Rapid urbanisation and lighting energy consumption have resulted in increasing urban light pollution in major cities, especially in developing countries. Many light pollution consequences have to be balanced with the many benefits derived from the use of lighting from public or private premises.[171] While some countries have promoted legal measures to reduce light pollution emission from premises, light pollution measures are not yet to be adopted in many national and municipal jurisdictions.

So, this part of the research is to increase clarity and predictability in relation to a number of light pollution forms and their harmful effects, including their significant impacts. The classification of light pollution causes or forms may significantly highlight how balance between urbanisation, industrialisation and electricity consumption for lighting could be done by national and local governments. Similarly, there has to be greater awareness about the need for precaution with light pollution and ability to adopt a good balance between lighting use and the need for protecting the environment.

There are many different ways that lights can become polluting. The most common forms of light pollution are inappropriate or misdirected lighting. Also, most technical forms of light pollution are specified in illuminating engineering or lighting architectural terms. This might bring about the opportunity to resolve the matter before light pollution disturbs the environment, ecological system and human well-being. Despite differences in various forms of light pollution, some unclear boundaries or complicated areas of light pollution form is considered where the lack of coherence in national and international definitions of light pollution can make legislation very difficult. So, this research also provides information on causes or forms of light pollution in many contexts and highlights the current issues, future changes and case studies involving all the various requirements of light pollution forms.

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[171] City of Edinburgh, Edinburgh's *Environment: State of the Environment Audit: Light Pollution*, City of Edinburgh, at paragraph 3.16, available from http://www.edinburgh.gov.uk/downloads/file/4513/light_pollution accessed 11 June 2013.

3.2 Glare

Glare is a form of unwanted consequence of outdoor lighting and includes such effects as visibility for road users[172], workers[173], aviators[174] and pedestrians. The visual sensation caused by excessive and uncontrolled brightness from glare also leads to various visual problems of annoyance and discomfort. Glare sources can reduce our ability to see other objects, or simply cause annoyance.[175] There are two main forms of glare. Firstly, disability glare causes a loss of visual sensation from stray light being scattered within the eye. Secondly, discomfort glare is the visual sensation of annoyance or even pain induced by excessive or inappropriate bright lighting sources.[176]

Excessive and misdirected lighting[177] can lead to difficulty seeing in the presence of bright light, for example, the risks arising out of or in connection with inappropriate or non-environmentally friendly lighting practices of vehicle lights or lights used in and on aircraft and at airports.[178] A consequence of unwanted or inappropriate lighting causes a

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[172] However, with the right practices of driving techniques, headlight fixtures, and other outdoor light installation associated traffic lighting, the following methods of glare control may reduce unsafe problems from over brightness or excessive illumination from glare. See AAA Foundation for Traffic Safety, *How To Avoid Headlight Glare*, available from https://www.aaafoundation.org/sites/default/files/HeadlightGlareBrochure.pdf accessed 20 June 2013.

[173] The degree of glare in the workplace can not only affect occupational health and safety, but it is also linked to waste of energy in the workplace. Employers to have arrangements in place to cover health and safety should be required for Managing the health and safety risks from glare in the workplace under the Management of Health and Safety at Work Regulations 1992 (MHSW). See Health & Safety Executive, *Lighting at Work*, Her Majesty's Stationery Office, 2002, pp 7-8.

[174] Many air transportation hazards can result when light beams intersect aircraft's path. There are many primary concerns of glare problems, such as temporary flash blindness and eye injuries. See Murphy, P. , *Lasers and Aviation Safety Version 2.2*, International Laser Display Association, September 2009, pp 1-18. available from http://www.laserist.org/files/Lasers-and-aviation-safety_2pt2.pdf accessed 20 June 2013.

[175] Vos, J. J., 'On the cause of disability glare and its dependence on glare angle, age and ocular pigmentation', *Journal of Clinical and Experimental Ophthalmology*, 2003 86 (6), pp 363-370. and See Vos, J. J., Reflections on glare, *International Journal of Lighting Research and Technology*, 2003 35 (2), 163-176.

[176] Lighting Research Centre, *What is glare?*, available from http://www.lrc.rpi.edu/programs/nlpip/lightinganswers/lightpollution/glare.asp accessed 20 June 2013.

[177] Osterhaus, W. K. E. and Bailey, I. L., *Large Areas Glare Sources and Their Effect on Discomfort and Visual Performance at Computer Workstations*, University of California, 1992, pp 1-7.

[178] Hermann, C., 'The International Commission on Illumination - CIE: What It Is and How It Works', *Preserving the Astronomical Sky, Proceedings of IAU Symposium*, 1999 July, p 60.

loss of visibility from objectionable brightness transients. An objectionable brightness or reflection of light and a driving hazard especially bothersome for automobile drivers and aviators is glare.[179]

Excessive brightness from artificial light refers to the excessive amount of artificial light that occurs when trying to look at an object.[180] It can reduce visibility and increases the chance for road accidents. Inappropriate illuminance from road glare sources, for example, headlights, streetlights, security lights and reflective materials, can cause visual discomfort and/or disability. Very strong relationships have been established between glare and accident risk: The general relationship holds for road glares and road users, but the accident risk from motor vehicle glare varies with the initial glare degree and causes, for example[181], glare angle, interaction of beam pattern, distance and angle, driver age, background luminance, as well as areas of glare sources.[182]

Several lighting governing bodies and research assumes that the effectiveness of lighting might prevent road accidents.[183] Many research papers' conclude from statistically analysing the studies that street lighting can prevent road traffic accident results, such as road traffic crashes, injuries and fatalities.[184] Since opinion is divided on

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[179] Center for Environmental Excellence & American Association of State Highway and Transportation Officials (AASHTO), *Environmental Stewardship Practices, Procedures, and Policies for Highway Construction and Maintenance*, Venner Consulting and Parsons Brinckerh off, 2004, para 3-142. available from http://environment.transportation.org/documents/nchrp25_25_files/nchrp_chapter_3.pdf accessed 20 June 2013.

[180] Industrial Accident Prevention Association, *A Health and Safety Guideline for Your Workplace: Lighting at Work*, Industrial Accident Prevention Association, Industrial Accident Prevention Association, 2008, p 40.

[181] Mace, D., *Glare and Nighttime Roadway Visibility*, available from http://www.lrc.rpi.edu/programs/Transportation/pdf/causesGlare.pdf accessed 21 June 2013. and See Boyce, P., Glare and Nighttime Roadway Visibility: Human Factors, available from http://www.lrc.rpi.edu/programs/Transportation/pdf/humanFactorsGlare.pdf accessed 21 June 2013.

[182] Marchant, P. 'What is the contribution of street lighting to keeping us safe? An investigation into a policy.', *Radical Statistics Journal Issue 102*. available from http://www.radstats.org.uk/no102/Marchant102.pdf accessed 21 June 2013.

[183] Ward, H., Shepherd, N., Robertson, S. & Thomas, M., *Night-time accidents: A scoping study Report to The AA Motoring Trust and Rees Jeffreys Road Fund*, Centre for Transport Studies University College London, October 2005, pp 1-8. and See Beryer, F. R. & Ker, K., *Street lighting for preventing road traffic crashes and injuries*, 2009 Cochrane Database of Systematic Reviews, available from http://www.cochrane.org/reviews/en/ab004728.html accessed 21 June 2013.

[184] Royal Society for the Prevention of Accidents, *Road Safety Information Street Lighting and Road*

the matter, it could be that the link between traffic accident prevention and reduction, and streetlighting is an important subject for further research.

Effective or appropriate outdoor lighting should be sensitively applied, providing an even and generous distribution of light with the maximum reduction in shadows.[185] In contrast, excessive brightness from outdoor glare is able to produce high contrast shadows. With inadequate illumination resulting in shadow areas it might be possible for criminal offenders to hide in the shadows. Therefore, in order to enhance quality of life and to reduce both the incidence and fear of crime, crime prevention through environmental lighting design and fixtures may support crime surveillance that allows people engaged in their normal activities to easily observe the space around them, as well as eradicating hiding areas for criminal offenders engaged in criminal activities.[186]

The complexity of the human-made glare problems does not only leads to a complex mix of astronomical, environmental and economic impacts, but also poorly designed, directed or maintained lighting in architectural design can have undesirable effects on visual comfort through being too bright. Many purposes of architectural lighting forms create added value for the facade and landscape.[187] As architectural lighting design is becoming a common response for exterior architecture, it would seem essential to direct architects or designers towards light pollution aspects for contemporary architectural lighting design and fixtures.

Many lighting architects and designers recognise a variety of exterior lighting design objectives where lighting plays an important role for night beautification as well as lighting utilities, for example, safety, appearance and comfort, including visual sizes of details and lighting vertical surfaces.[188] On the other hand, if architectural lighting

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Safety, Royal Society for the Prevention of Accidents, 2013, pp 1-3.

[185] London Borough of Barking & Dagenham, *Planning Advice Note 6 Crime Prevention through Environmental Design*, London Borough of Barking and Dagenham, 2009, p 24.

[186] Office of Neighbourhood Involvement Crime Prevention Program, *Crime Prevention Through Environmental Design*, available from available from http://www.portlandoregon.gov/oni/article/320548 accessed 24 June 2013.

[187] Zumtobel, *Light for facades and architecture*, Zumtobel, 2010, p 3.

[188] Cayless, M. A. & Marsden, A. M. *Lamps and Lighting: A Manual of Lamps and Lighting*, 3th edition, Arnold, 1983, p 421.

design is not considered in good lighting practices, it may have devastating results. Many results of inappropriate lighting design, such as lack of attention of architectural detail and value, are the cause of glare.[189] Therefore, lighting designers should realise that bad architectural lighting design can involve several associated glare problems for architectural design and the night environment.

3.3 Sky Glow

Sky glow or upward light is either emitted directly upward by luminaires or reflected from the ground and scattered by dust and gas molecules in the atmosphere, producing a luminous background on the sky.[190] This also includes the characteristic orange glow, typically seen over towns and cities, which is produced by sodium lighting. Many common forms of sky glow generally found in urban areas and city centres are, for example, street lighting, security lighting, floodlights and advertising lighting. [191] Sky glow is the brightening of the night sky above our urban areas or landscapes[192] that causes risks and arises out of, or in connection with, inappropriate or non-environmentally friendly lighting practices of people as well as public or private premises.[193]

The atmospheric smog that hangs over towns and cities at night generally increases night sky brightness. Rapid urbanisation has resulted in increasing urban light pollution in urban areas or landscapes, especially in district brightness areas because lighting at

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[189] For example, glaring hot sports in the wrong place at the wrong time can reduce value of design. See Kay, G. N. *Fibre Optics in Architectural Lighting Methods, Design and Application*, McGraw-Hill, 1999, pp 74-85.

[190] Lighting Research Centre, *What is sky glow?*, available from http://www.lrc.rpi.edu/programs/nlpip/lightinganswers/lightpollution/skyGlow.asp accessed 1 July 2013.

[191] Shi, J., *Reducing Artificial Nighttime Light Pollution and Its Impacts*, Standford University, August 2010, available from http://www.trianglealumni.org/mcrol/EPA-NNEMS_Light_Pollution_Final.pdf accessed 2 July 2013.

[192] Dark Sky Society, *Guidelines for Good Exterior Lighting Plans*, Dark Sky Society, 2009, pp 1-6.

[193] Sky glow where the night sky is illuminated when upwardly directed light reflects off particles in the atmosphere creates adverse environmental effects that gradually destroy the natural night environment and world heritage of dark skies, including considerable energy waste. This is generally caused by inappropriate fixtures as well as non-environmentally friendly design. See McCawley, M., *Air, Noise, and Light Monitoring Results For Assessing Environmental Impacts of Horizontal Gas Well Drilling Operations (ETD-10 Project)*, West Virginia Department of Environmental Protection, 2013, p 14.

night still need to be used to promote a better quality of urban life and people have more time to enjoy outdoor activities at night.

The rapid expansion of cities and city centre regions[194] has been become a main environmental issue in the global effort to achieve environmental protection and sustainable development.[195] Urban sprawl is one of the most important causes of urbanisation and land-use change currently affecting many parts of the world. It generally occurs in urban development areas that allow unrestricted urban growth or that have no planning regimes for urbanisation control. Economic, social, and political progress can contribute to rapid urban growth and development.[196]

Artificial light that is allowed to illuminate areas intended to be lit in commercial places and premises can occasionally promote business and commercial benefits. Outdoor advertising and display lights at night[197] are able to attract consumers' attention by their commercial or industrial advertisement. They might influence consumer decision-making when advertising and consumer culture has commercially dominated everyday life.

However, urban sprawl has created numerous light pollution problems. The considerable impacts of urban sprawl from inappropriate or excessive use of lights are exacerbated by the increased proximity and accessibility of outdoor activities to urban areas, imposing stress on ecosystems and human beings through human-made upward

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[194] BRAC Regional Task Force, *Light Pollution in the Fort Bragg Region of North Carolina*, BRAC Regional Task Force, available from available from http://www.bracrtf.com/documents/LightPollutionStudy.pdf accessed 24 June 2013.

[195] European Commission, *Creating a world of sustainable cities: Research for sustainable urban development and land use - UN-HABITAT and the EU*, European Commission EUR 21157, 2004, pp 1-15.

[196] The economic and demographic growth of urban centres has to take place within an environmental, social and political framework conducive to the more equitable distribution of resources, both within the present generation and between present and future generations. See UN-HABITAT & Department for International Development, *Sustainable Urbanisation Achieving Agenda 21*, UN-HABITAT & Department for International Development, 2002, p 6. available from http://www.ucl.ac.uk/dpu-projects/drivers_urb_change/official_docs/Sustainable%20Urbanisation-Agenda%2021.pdf accessed 1 July 2013.

[197] Office of Fair Trading, *Outdoor advertising: An OFT market study*, Office of Fair Trading OFT 1304, 2011, p 14.

lighting emissions.[198]

Sky glow contributes a lot to the negative impacts on human beings and the night environment.[199] Firstly, this issue has been recognised as a serious astronomical impact related to cultural and natural heritage relating to astronomy.[200] Sky glow is able to interfere with astronomical instruments because it generally makes the sky much brighter than the natural dark sky at night. Consequently, professional and amateur astronomers may not normally observe or view astronomical phenomenon and sky objects. Sky glow over urban town and cities not only impacts on normal usage of astronomical tools or equipment, but it also limits naked-eye astronomy. The beauty and wonder of the natural dark sky is destroyed by the great rapid increase in urban sky glow due to outdoor lighting. Therefore, professional and amateur astronomy has particularly suffered with the inability to observe through polluted skies.

Secondly, many scientific reviews of the sky glow information indicate that sky glow alters natural light regimes in terrestrial and aquatic ecosystems.[201] With the expansion of urban development and living areas near or within naturally ecological areas[202], various common and endangered species and habitats have been being destroyed by extensive use of urban lighting for many reasons.[203] The atmospheric smog from urban

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[198] European Commission Directorate-General Joint Research Centre & European Environment Agency, *Urban sprawl in Europe: The Ignored Challenge*, European Commission Directorate-General Joint Research Centre EEA Report No 10/2006, 2006, p 31.

[199] Macedo, F., *LED Streetlights - General Specification: A Guidelines for LED Design and Selection*, Gelco Development USA, 2013, available from http://energyworksus.com/pdf/led_streetlights_guide.pdf accessed 2 July 2013.

[200] United Nations Educational, Scientific and Cultural Organization & World Heritage Centre, *Natural heritage relating to astronomy*, United Nations Educational, Scientific and Cultural Organization & World Heritage Centre, available from http://www2.astronomicalheritage.net/index.php/about/categories-of-astronomical-heritage/natural accessed 2 July 2013. and See Iwaniszeski, S., *Astronomy in Cultural Landscapes: New Challenges for World Heritage Issues*, Forum UNESCO University and Heritage10th International Seminar "Cultural Landscapes in the 21st Century" Newcastle-upon-Tyne, 11-16 April 2005, p 7.

[201] Sky glow can be distinguished from 'ecological light pollution' that alters natural light regimes in the night environment and ecological regimes. Longcore, T. & Catherine, R., 'Ecological light pollution', *Frontiers in Ecology and the Environment* 2004 2 (4), pp 191–198.

[202] Wise, S., *Study the ecological impacts of light pollution on wildlife: amphibians as models*, Utica College, 2007, pp 107-116.

[203] Holden, A., 'Lighting the Night: Technology, Urban Life and the Evolution of Street Lighting', *Places*

brightening of the night sky above towns and cities that hangs over urban areas at night significantly affects wildlife, habitats, and their ecological systems in many ways as mentioned in Chapter 4. Artificial lighting at night generally degrades the visual environment and can disrupt the ability of orientation or disorientation from sky glow in urban areas. It has the potential to persist in the night environment where sky glow negatively leads to many changes in orientation, disorientation, or misorientation, and attraction or repulsion from orange smog in urban areas, which in turn may disrupt the ability of foraging, reproduction, migration, and communication.[204] For example, sky glow disrupts marine turtle hatchlings' direction finding because light pollution from land may confuse them.[205] Similarly, sky glow may also affect ability avian orientation[206] because birds mistake the sky glow over nearby urban areas for the sunset.[207] Indeed, light pollution may prevent birds migrating by the sun and stars.

3.4 Intrusive Light

Intrusive light occurs when spill light is cast where it is not wanted[208] or when light emitted by a lighting installation that falls outside the boundaries of the property or landscape on which the installation is sited.[209] Intrusive lighting in the wrong place at the wrong time may be introduced as artificial light allowed to shine on surrounding

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Journal 1992 8 (2), pp 56-63.

[204] Wyneken, J., Salmon, M., & Lohmann, K. J., 'Orientation by hatchling loggerhead sea turtles in a wave tank' *Journal of Experimental Marine Biology and Ecology* 1990, 139, pp 43-50, available online from http://www.science.fau.edu/biology/faculty/Wyneken/DOC050817-006.pdf accessed 4 July 2013. and See Sheppard, C., *Bird-Friendly Building Design*, American Bird Conservancy, 2010, p 38.

[205] Florida Highway Administration, 'Installing turtle-friendly lighting on Florida's coastal roadways', *Successes in Stewardship Newsletter* 2012, May, pp 1-3.

[206] Alerstam, T., *Bird Migration*, Cambridge University Press, 1990, pp 378-382 and Matthews, G.V.T., *Bird Navigation*, Cambridge University Press, 1995, pp 56-58 & pp 77-78.

[207] Gustav Kramer was the first to discover that natural light was naturally used by different avian species to navigate. He also discovered the sun compass orientation in birds. See Chandrashekaran, M. K., 'Biolocical rhythms research: A personal account', *Journal of Biosciences* 1998 23 (5), pp 545-555. available from http://www.ias.ac.in/jbiosci/december1998/no5b.pdf accessed 8 July 2013.

[208] Lighting Research Centre, *What is light trespass?*, available from http://www.lrc.rpi.edu/programs/nlpip/lightinganswers/lightpollution/lightTrespass.asp accessed 9 July 2013.

[209] Maine Coastal Program & SPO Maine State Planning Office, *Technical Assistance Bulletin Light Manual: Promoting Quality Outdoor Lighting in Your Community*, SPO Maine State Planning Office, 2013, p 13.

areas not intended to be lit. Furthermore, the intrusion of lighting may be defined as light spilling beyond the boundary of the property or areas on which a light is located, sometimes shining through windows and curtains, including private areas.[210]

Unwanted light entering a property from a neighbouring property's lights not only interferes with the comfort and enjoyment of another's home and surroundings, but it also give rise to both human well-being and concerns about serious health effects. Several medical studies and reports show increased risk to the human immune system and cancer. It has been implicated in the disruption of the human and animal circadian rhythm, and strongly suspected as an etiology of suppressed melatonin production, depressed immune systems, and an increase in cancer rates as mentioned in Chapter 4.[211]

As mentioned in more detail previously, intrusive light should be legally bound by the terms of a particular definition because the following terms and their variant forms of intrusive light may certainly bring about clarification of the meaning of intrusive light. The requirements of useful human being protection from intrusive light should be added to address legal contexts aimed at clarifying the interpretation that should be given to that concept in the definition of intrusive light and its adverse concerns.

Unfortunately, considerable variation of intrusive light definitions is associated with some issues of the legal terminology. This may lead to confusion when people attempt to define intrusion of lighting in illuminating engineering term as well as legal terms. Technically, awareness of inappropriate lighting is generally promoted by illuminating engineering bodies and architectural lighting bodies, including the astronomical movement. Many aspects of light pollution from different disciplinary backgrounds may lead to confusion when specialists attempt to set up a specific definition of lighting intrusion. In addition, the lack of consistency among different perspectives or multidisciplinary approaches particularly heightens confusion or overlap regarding

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[210] Basingstoke and Deane Borough Council, *Light pollution: What to do to reduce it or if you experience it*, Basingstoke and Deane Borough Council, 2012, p 2.

[211] American Medical Association, *American Medical Association House of Delegates Resolution: 516 (A-09)*, American Medical Association, pp 1-2.

lighting intrusion definitions as well as terminology.

For example, in England the difference between trespass in illumination engineering[212] and trespass in law[213] can lead to confusion when people attempt to comprehend or perceive their terms and concepts. More recently the concepts of light pollution have been discussed and analysed in relation to illumination engineering aspects, architectural lighting aspects and legal principles. Although various factors may influence awareness of the light pollution problem by describing variation associated with disciplinary terminology, light trespass is commonly identified as a result of lighting intrusion.[214] Light trespass may be viewed as an architectural concept, i.e. light trespass from inappropriate track lighting which occurs when inappropriate architectural light degrades effectiveness and value of architecture activities, or as an illuminating engineering term, i.e. light trespass which occurs when unwanted light enters a property from a neighbouring property is defined by illuminating engineering and lighting architecture guidance.[215] However, light trespass is not trespass in law because the background relating to trespass in English criminal law and civil law consists of three common characteristics of trespass; trespass to the person, trespass to goods and trespass to land. Therefore, light trespass is not currently addressed or dealt with by English trespass law, which generally makes a number of criminal offences as well as having civil actionable characteristics. The overlap between light trespass in engineering or architectural aspects and light intrusion in law might perhaps lead to

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[212] Klein, R. D., *How to Win Land Development Issues: A Citizens Guide To Preserving & Enhancing Quality of Life in Developing Areas Through Responsible Growth Management*, Community& Environmental Defense Services, 2007, pp 64-65.

[213] Strickland, P., *Trespass to land*, Home Affairs Section, 2014, pp 1-6.

[214] The detrimental effects on normal living activities (e.g. unable to use a bedroom) or preventing enjoyment of property (e.g. unable to use gardens) can probably be attributed to light intrusiveness. See Department for Environment Food and Rural Affairs, *An Investigation into Artificial Light Nuisance Complaints and Associated Guidance Final Report*, Department for Environment Food and Rural Affairs, 2010, p 34. available from http://archive.defra.gov.uk/environment/quality/local/nuisance/light/documents/artificial-light-nuisance-report2010.pdf accessed 9 July 2013.

[215] For example, surrounding neighbours can suffer from poorly designed festoon lights although exterior festoon lighting may demonstrate enhancement of the beautification appearance of the building and surroundings. See *Westminster City Council v. Verjee* (1992) 7 PAD 572 Sweet & Maxwell, *Current Law Yearbook*, Sweet & Maxwell, 1992, at para 4200.

misunderstanding occurring when there is a failure to understand or interpret engineering or architectural terminology, as well as legal words, correctly.

One of the most predictable questions about intrusive light is what light intrusion's impacts are and what happens if we want to make a complaint about an intrusion of lighting because of disruptive behaviour or annoying interference? Since the start of legal enforcement of the statutory light nuisance in England in 2005, the Government has applied a recent statutory framework of intrusive lighting control.[216] The *Clean Neighbourhoods and Environment Act 2005* amended the *Environmental Protection Act 1990* to bring artificial light from premises under the statutory nuisance regime as of 6 April 2006. The Act set out a new regime of light pollution control from light intrusion.

Section 102 of the Act involves how to identify when lighting is causing a statutory nuisance, and when and how to use enforcement powers. It specifically creates a recent form of statutory nuisance from artificial light namely '*artificial light emitted from premises so as to be prejudicial to health or a nuisance*'.[217] However, this does not deal with intrusive light emitted. From premises such as those used for transport purposes and other premises where high levels of light are required for safety and security reasons. '*It does not apply to artificial light emitted from airports, harbours, railway premises, tramway premises, bus stations and associated facilities, public service vehicle operating centres, goods vehicle operating centres, lighthouses, prisons and premises occupied for defence purposes*'.[218] Moreover, a statutory defence of '*best practicable means*' will be available to artificial light emitted from industrial, trade or business premises and artificial light emitted by lights used for the purpose only of illuminating an outdoor relevant sports facility.

Intrusive light in the wrong place at the wrong time can be a material interference with the comfort and enjoyment of a home and surroundings. Even though many national

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[216] Department for Environment Food and Rural Affairs, *Statutory Nuisance from Insects and Artificial Light: Guidance on Sections 101 to 103 of the Clean Neighbourhoods and Environment Act 2005*, Department for Environment Food and Rural Affairs, 2006, p 6.

[217] UK Legislation, *Clean Neighbourhoods and Environment Act 2005*, available from http://www.legislation.gov.uk/ukpga/2005/16/contents accessed 9 July 2013.

[218] Ibid.

and local jurisdictions have developed laws relating to light intrusion control, English statutory nuisance from artificial light cannot deal with all situations involved to satisfy all of the lighting requirements. Light pollution control laws commonly require one or both of the limitation of the spill light at or just beyond the area being lighting, usually expressed in lux (or foot candles) and the limitation on the luminance (physical brightness) of the luminaires when viewed from outside the primary area being lighted.[219] However, the *Clean Neighbourhoods and Environment Act 2005* does not include all intrusive lights emitted from public service premises where used for transport purposes or where used for safety and security reasons.

Furthermore, although unwanted light intrusion is able to affect people's quality of life, current statutory nuisance provisions cannot describe all technical methods for efficient control of light intrusion. The current provisions under English jurisdiction may not be concerned with potential light pollution of all categories of planning development and urban residential areas. Similarly, the English statutory nuisance is defined simply as '*artificial light emitted from premises so as to be prejudicial to health or a nuisance*', although this legislation does not apply or cover to all intrusive lights. It seems then that light statutory nuisance under English jurisdiction may not tackle all aspects of light intrusion. For example, the impact of light intrusion can interfere with the surrounding ecosystem in urban areas and inappropriate management practices in light design and fixtures may lead to a decline in surrounding environment. Although statutory nuisances give the power to investigate complaints of light nuisance and to take action if we are satisfied that the matter is an unreasonable effect on a person's enjoyment of their property, provisions of statutory nuisance are not beneficial instruments for environmentally friendly responsible outdoor lighting in England. The current provisions in English jurisdiction are not specifically designed to help local authorities develop outdoor lighting standards that reduce light intrusion.

3.5 Clutter

Clutter is bright, confusing, and excessive groupings of light sources, commonly found

[219] Lewin, I., *Light Trespass and Light Pollution- Practical Approaches to Dealing with Problems*, IESNA Street and Area Lighting conference Minneapolis, September 2000, p 7.

in over-lit urban areas.[220] The proliferation of clutter contributes to urban sky glow, intrusion, and glare.[221] It is a broad term associated with three main elements of light pollution. Confusion from light clutter is able to diminish the night environment and dark landscapes. Consequently, the adverse aesthetic effect at night caused by excessive or obtrusive light is characterised as clutter. Environmentally friendly design should be used to enhance the aesthetics of the dark landscapes, not destroy it.[222]

Several elements of light pollution are generally combined and overlapping because excessive or obtrusive lighting in the wrong place at the wrong time can lead to many different forms of light pollution.[223] The complex interrelationships among uses of light sources have resulted in environmental problems made worse by increased use of inefficient lighting. For example, street lighting is still the main contributor to various aspects of light pollution. It involves many forms of light pollution, such as wasted light shining into the sky, intrusive light and disability glare. They present controversies over the proper relationship between human and night environment such as sky, atmosphere and natural dark landscapes.

Various elements of light pollution are often combined and overlapping[224], but as with all forms of light pollution, are made worse by their general proliferation. Clutter from outdoor lighting can also be harmful to the night environment causing a lot of damage to ecosystems, atmospheric beautification and human health. Therefore, future clutter control should be likened to the concept of mixed light pollution precaution, for it is at once both ambiguous and complicated; broadly appealing but a cause for scepticism.[225]

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[220] Dense volumes of illumination cause an intense light clutter that is able to grab attention and distract from the true object of a human eye either directly, or through a CCTV camera system. See Raytec, *The Complete Guide to CCTV Lighting*, Raytec, 2007, p 26.

[221] International Dark-Sky Association, *Biological clock and circadian rhythm*, International Dark-Sky Association, 2008, pp 1-2.

[222] Shaflik, C., *Light Pollution: Environmental Effects of Roadway Lighting*, Technical Paper prepared for: CIVL 582 - Transportation Engineering Impacts, University of British Columbia, 1995, p 13.

[223] International Dark-Sky Association, *Light Pollution and Safety*, International Dark-Sky Association, 2010, pp 1-2.

[224] International Dark-Sky Association, *Light Pollution and Safety*, International Dark-Sky Association, 2008, pp 1-2.

[225] Jordan, A. and O'Riordan, T., *The Precautionary Principle in U.K. Environmental Law and Policy*,

3.6 Light presence

Light presence is the term used to describe over bright lighting seen over towns and premises from mixed elements of light pollution.[226] Lights from other areas such as industrial, commercial and outdoor sports facilities may deliver misdirected lights or over bright lighting that contributes to the presence of light at night. In spite of this, environmental planning zones or landscapes in relation to night environment quality thresholds should be set by the Government and other planning authorities. The zoning control of light pollution may deliver adequate and coordinated measures to reduce the presence of light at night. Where risks of light pollution impacts exist, they should appropriately develop national, regional or local light pollution maps and night environment risk maps for such areas. These maps may identify the restricted zones for outdoor lighting control.[227] However, in achieving light presence reduction targets, the restricted zones might differ between several causes of brightness landscapes or outstanding dark locations.

The consequence of urban sprawl from rapid urban expansion and the density of population of urban areas generally impacts on how much lighting energy is consumed. Urban sprawl has created opportunities for significantly higher levels of lighting energy consumption. Lighting energy plays a significant role in many aspects of urban lives. For example, urban lights are used for many reasons, such as security lighting, street lighting, floodlighting, sports lights advertising and display lighting as well as sports and recreational area lighting. Nevertheless, light pollution from lighting being installed poorly in both public and private premises will potentially give various elements of unwanted, and wasted, light. Therefore, many serious efforts have begun in England to curtail the growing levels of pollution that have been degrading the night environment.

Although an important role of the national Government in mitigating the adverse effects of light pollution has been highlighted by the National Planning Policy Framework

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Centre for Social and Economic Research on the Global Environment Working Paper GEC 94-11, 2011, pp 1-30.

[226] Clancy Consulting Limited, *Rose Energy Project: Light Pollution Study*, Clancy Consulting Limited, 2008, p 22.

[227] Environmental Protection UK, *Light Pollution*, Environmental Protection UK, May 2010, p 7.

2012[228], the amount of light used in urban areas is influenced by energy consumption of public lighting infrastructure.[229] Therefore, installation of a large number of light infrastructure systems associated with rapid physical growth of urban settlements[230] may increase levels of light pollution and levels of obtrusive light that shone into urban areas, where urban light emitted from light sources, or that projected on to the urban area or landscape.

Urban light pollution may have significant impacts when the presence of light is excessive or obtrusive and starts to have an adverse impact on night environment and human being that it becomes problematic. For example, inappropriate and unshielded outdoor lighting at night has resulted in light presence through spillage onto surrounding residential areas, as well as urban premises. Although it may draw attention to the existence of a lighting installation, or structure that was previously inconspicuous by day[231], there is obviously not a specific legal instrument to control light presence at the time of writing.

3.7 Flicker

Flickering light is probably best described as a rapid and repeated change over time in the brightness of artificial light.[232] It is a side effect of advertising signage, commercial attractions and sports lighting. Flickering light may cause many unintentional biological effects of flickering light of annoyance and irritation to the viewer, such as malaise, headaches and impaired visual performance.[233] The increase in the use of flicker in

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[228] Department for Communities and Local Government, *National Planning Policy Framework*, Department for Communities and Local Government, 2012, p 29.

[229] Radocha, M. & Baumgartner, B., *Energy Efficiency in Transport Infrastructure and Streetlighting*, COMPETENCE & Intelligent Energy Europe, pp 1-14.

[230] House of Commons International Development Committee, *Urbanisation and Poverty Seventh Report of Session 2008–09 Volume I*, House of Commons HC 511-I, p 20.

[231] Scottish Executive, *Guidance Note Controlling Light Pollution and Reducing Lighting Energy Consumption*, Scottish Executive, 2007, p5.

[232] Wilkins, A., Veitch, J. & Lehman, B., *LED lighting flicker and potential health concerns: IEEE standard PAR1789 update*. IEEE Energy Conversion Congress and Exposition, 2010, pp. 171-178.

[233] Institute of Electrical and Electronics Engineers, *A Review of the Literature on Light Flicker: 1 Ergonomics, Biological Attributes, Potential 2 Health Effects, and Methods in Which Some LED 3 Lighting May Introduce Flicker*, Institute of Electrical and Electronics Engineers IEEE Standard P1789, 2010, pp 1-26. available from http://grouper.ieee.org/groups/1789/FlickerTR1_2_26_10.pdf accessed 02

commercial and public works in recent years has brought about issues related to human beings and legal issues. For example, flicker which shines outside the area it is intended to illuminate can be an artificial light nuisance and flicker which shines in wrong place at wrong time can impact on human health as mentioned in Chapter 4.

The glare and flicker components might be combined and overlapping because the periodic, generally deliberate, flickering light used for commercial advertising and emergency warning purposes can prove to be distracting and, like glare, promotes degrees of irritation, annoyance and distress.[234]

Although, as people look for ways to conserve energy, save on electric bills and protect the night environment, use of flickering light is increasing, some of the light premises that make flicker can also cause various concerns in light pollution issues. Although flickering light is essential and people use it for many different reasons, lighting governing bodies specifically seek to avoid misdirected, excessive, inefficient or unnecessary lighting. The absence of balancing the interests between necessary flicker light uses and awareness of environmental harms has resulted in environmental problems.

Flickering light in the wrong place at the wrong time can be obtrusive or intrusive. The legal regimes should impose appropriate methods, especially on use of flickering light sources which are not created for misdirected, excessive, inefficient or unnecessary lighting purposes, or which might be found to be out of best practice. Therefore, the English legal regime should consider several upcoming flickering light issues which deserve attention. For example, there is no specific term that provides a straightforward means of determining whether flickering light control is sufficiently practiced. The current legal regimes do not offer a specific planning mechanism for flicker control.

For example, inappropriate flickering light or inadvisable flickering light from advertising banners as well as message that changes more than once every second have

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August 2013.

[234] Scottish Executive, *Guidance Note Controlling Light Pollution and Reducing Lighting Energy Consumption*, Scottish Executive, 2007, p 6.

resulted in improper light displays and design. So, the flickering light display should be placed or installed in an appropriate position or under any best practice of the outdoor lighting conditions, if the advertising structure or sign visible from a regulated highway, displays, any flicker, intermittent, or moving light or lights.

Chapter 4: Legal Light Pollution Definition

Chapter 4 is intended to serve as a technical resource for legislators, policy makers, and other light industrial stakeholders focusing on the legal definition of light pollution. This Chapter investigates how the light pollution generated by non-environmentally friendly lights will be legally defined, or how the legal contexts of light pollution will be termed by the law.

The two types of official definitions of light pollution (for example legally binding and non-legally binding definitions) used by the legislators, policy makers, and other light industrial stakeholders in the area of environmental and planning laws are necessary[235] because they include either characterisation of the definition of light pollution or technical guidance of light pollution so as to make clear to what the regime will apply to. They are based on enforceable and remedial action[236], meaning that they allow legislators, policy makers, and other light industrial stakeholders to retain environmental protection standards.

However, currently there are very few non-legally binding definitions of light pollution and, apart from in professional illuminating engineering or under soft law, there is no legally binding definition under which light pollution can be officially characterised and statutorily remedied.[237] For example, local authorities may be required to inspect their areas for outdoor lighting control within their urban development plans. Nonetheless, they may not be able to identify that the character of non-environmentally friendly or inappropriate lights needed to be taken into account as part of the environmental protection objectives.

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[235] Hawkins, K., *Environment and Enforcement: Regulation and the Social Definition of Pollution*, Clarendon Press, 1984, p 253.

[236] Food and Agriculture Organization of the United Nations, *Chapter 1 - Potential Pollutants, their Sources and their Impacts*, available from http://www.fao.org/docrep/x5624e/x5624e04.htm accessed 29 April 2013.

[237] A better ability to characterise light pollution elements and predict scale of light pollution, a clear legal definition of light pollution may be able to help the official authorities in their light pollution control activities. Non-environmentally friendly or inappropriate lighting activities can be characterised by particularly legal terminology of light pollution, which necessitate some subjective decisions on the resolution of the enforceable and remedial processes. See Environment Agency, *Characterisation and prediction of large-scale, long-term change of coastal geomorphologic behaviours: Final science report*, Environment Agency, 2009, p 18.

This Chapter will be responsible for adding meaningful academic debate, developing characterisation of light pollution, and unifying a single legal definition of light pollution where necessary, including through different disciplinary solutions. It especially recognises the need for further detail on unification of legal contexts of light pollution definition. A single definition of light pollution is an ideal platform to demonstrate the willingness to work towards unification of a light pollution definition which would facilitate the classification, characterisation, assessment and remediation of light pollution.

4.1 Light pollution definition and the law

The quantity and nature of negative impacts of lighting activities should be regulated by environmental frameworks.[238] Legal definitions of light pollution and their boundaries must be clearly and certainly defined by local and national frameworks. National and local jurisdictions may clarify and simplify the legal definitions of light pollution. In order to comply with the objectives of legal lighting practices, local and national governments may take the necessary terms to attain the following targets covering light fixtures with environmental design and environmentally friendly materials. However, unclear light pollution terms and requirements may create unclear future light pollution practices. Unclear legal definitions may raise many gaps and many legal questions where light pollution issues and their contexts remain unanswered.

Whereas light pollution concepts are based on malpractices of lighting and their impacts on unnecessary lighting, terminology of light pollution may be based on necessary and sufficient contexts. Specialised terms of them could be a set of regulatory contexts in which the use of clear terms is restricted to special legal interpretation and finding rational support for subsequent aspects of legal reasoning.

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[238] United Nations Environment Programme, *Environmental law and Multilateral Agreements*, available from http://www.unep.org/training/programmes/Instructor%20Version/Part_2/Activities/Interest_Groups/Decision-Making/Core/Environmental_Law_Definitions_rev2.pdf accessed 29 April 2013.

4.1.1 Light pollution definition in English law

Despite the significance of light pollution terms to the success of light pollution control in English jurisdiction and other jurisdictions, there is no evidence to understand the best light pollution definition that difficulties either boundary of light pollution control or lighting practice have on legal enforcement. To understand light pollution terminology better as a result of this research text relating to the concerns of public authorities or other light pollution stakeholders, this discussion intends to provoke a discussion on other things that can be done to make guidance on the reform of future light pollution definition.

Even though many previous consultation papers on the reform of the UK light pollution frameworks contain general guidance as to how the new light pollution definitions should be established and contain examples of how the legal frameworks apply to various boundaries of light pollution scenarios[239], there is still no real light pollution meaning within the English statutory law.[240]

On 6th April 2006, the *Clean Neighbourhoods and Environment Act 2005* set up a new environmental aspect to the specific term of statutory light nuisance within the *Environmental Protection Act 1990*. This Act gives local authorities a range of new powers to tackle light pollution.[241] The victims of intrusive or obtrusive lighting related to statutory nuisance have a legal action open to them. They are able to take a civil action in private nuisance out against the offender, where they will have to prove the existence of the statutory nuisance under the *Clean Neighbourhoods and Environment*

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[239] House of Commons Science and Technology Committee, *Light Pollution and Astronomy Seventh Report of Session 2002–03*, House of Commons Science and Technology Committee HC 747-I, 2003, p 39. and See Royal Commission on Environmental Pollution, *Artificial Light in the Environment*, November 2009, p 13.

[240] Morgan-Taylor, M., 'Light Pollution and Nuisance: The Enforcement Guidance for Light as a Statutory Nuisance', *Journal of Planning & Environment Law*, 2006 August, pp 1114-1127.

[241] Department for Environment, Food and Rural Affairs, *Getting to grips with the Clean Neighbourhoods and Environment Act 2005 – a parish council guide to environmental enforcement*, Department for Environment, Food and Rural Affairs, 2006, available from http://archive.defra.gov.uk/environment/quality/local/legislation/cnea/documents/parishcouncilguide.pdf accessed 29 April 2013.

Act 2005.[242] Although local authorities can enforce whether intrusive or obtrusive lighting is a specific statutory nuisance under the *Clean Neighbourhoods and Environment Act 2005*, there still exists a significant limitation in the light pollution definition and its boundaries. This Act does not clearly extend light pollution definition to cover all aspects of light pollution emitted from all public or private premises. Despite this, there is a difference between light pollution and light nuisance, such that light nuisance may be, but is not necessarily the same as, light pollution. Accordingly applying statutory light nuisance in this way means if lighting is not defined by a statutory nuisance the local authorities have no powers to tackle it.

Only few non-legally binding definitions of light pollution which relate to classification, characterisation, measurement and remediation are retained by the professional astronomical or illuminating engineering bodies or even enhanced (as defined by the introduction of the light pollution in Chapter 1). Different disciplinary definitions[243] of light pollution may be seen to explain light pollution meaningfully, and soft law using professional astronomical or illuminating engineering practices can be literally characterised as necessary contexts of light pollution, that is, soft law with public oversight.[244] Nevertheless the differences of non-legally binding definitions on professional bodies' soft law observed in Chapter 1 means that any context of light pollution is likely to find common light pollution characters or terms as a suitable

[242] Morgan-Taylor, M. & Mizon, B., 'Light pollution now subject to the criminal law of statutory nuisance', *Journal of the British Astronomical Association*, 2005 115 (3), pp 119-126.

[243] Light pollution is a subject of non-environmentally lighting concern in different disciplinary researches from different perspectives. Astronomical and environmental problems have been investigated extensively from various disciplinary perspectives as mentioned in Chapter 2 & 3, whereas studies drawing upon other disciplines, e.g. illuminating engineering, architectural lighting design and other integrated and interdisciplinary approaches are rare. So, regulatory terminology of light pollution may be extracted from interdisciplinary approaches related to human health, the night environment and sustainable lighting development, clarifying the legal terms night environment in relation to outdoor light production as well as consumption. See Jeppesen, S., Andersen, J. E. and Madsen, P. V., *Urban Environmental Management in Developing Countries – Land Use, Environmental Health and Pollution Management – A Review*, Research Network on Environment and Development, 2006, p 1.

[244] For instance, the soft law itself introduce soft, non-legally binding targets and participatory component through the delegation of policy formulation to integral, co-operation networks, in a discipline where legally-binding emission limit values on light pollution used to be applied to several industrial sectors. See Terpan, F., 'Soft Law in the European Union the Changing Nature of EU Law', *European Law Journal*, 2015 1 (21), pp 68–96.

definitional explanation.

As described above, currently there is no legally binding definition under which light pollution can be officially characterised and statutorily remedied. There follows some points from this research about perceived lack of justifying the unification and harmonisation of a single legal definition on different disciplinary grounds in the English legal system.

Firstly, the environmental agencies and local authorities may not be able to legally characterise light pollution incidents based upon the environmental zoning for outdoor lighting control and obtrusive light limitations for outdoor lighting fixtures. An inadequacy of promoting uniformity and harmonisation of a single legally binding definition of light pollution in the English legal system is the most significant barrier to harmonising enforceable light pollution contexts and raises many obstacles in officially interpreting the definition of light pollution. As a result, legislators, policy makers, and other light industrial stakeholders are able to interpret light pollution definitions with reference to non-legally binding light pollution definition in different ways. If the Government does not prepare a single legally binding definition of light pollution for the convenience of all relevant stakeholders to provide access to a single legally binding definition of light pollution addressing particular contexts of light pollution, it cannot compulsorily require all stakeholders to lead the coordination of light pollution risk in the same ways through the public's understanding of the light pollution risks and how all stakeholders can play a part in reducing them.

Next, one significant reason for differences of a light pollution definition is that several numbers of metrics and measurements that have been developed for non-environmentally friendly or inappropriate outdoor lighting, based on wide ranging contexts of light pollution.[245] A definite lack of uniformity in the interpretation of a light pollution definition will lead to various difficulties of light practitioners in preparation and implementation of the necessary metrics and appropriate measurements

[245] Kamrowski, R. L., Limpus, C., Moloney, J. and Hamann, M., 'Coastal light pollution and marine turtles: assessing the magnitude of the problem', *Endangered Species Research*, 2012 November, available from http://www.int-res.com/articles/esr_oa/n019p085.pdf accessed 29 April 2013.

for controlling acceptable levels of outdoor light, based on different illuminating engineering indicators. For example, the legal contexts of the light pollution definition may be developed to set out the link between outdoor lighting practices and enforceable measurements to support the implementation of the necessary or appropriate metrics, which can indicate key elements of light pollution and quantify unacceptable level of outdoor light. The indicators[246] of the degree of artificial light nuisance or non-environmentally friendly annoyance may be used to define a context of light pollution definition.

Finally, legislators, policy makers, and other light industrial stakeholders may seek suitable and proportionate uniformity among different terms of non-environmentally friendly or harmful lighting in order to make the comprehensive regulatory definition more effective and less complicated for all individuals concerned.[247] Additionally, a single legally binding definition of light pollution may facilitate numerous functions of multi-disciplinary light pollution control. For example, environmental economists may extol the virtues of market-based or economic-incentive approaches to astronomical dark-sky conservation and night environment protection. The context of a single legally binding definition of light pollution may be analytically used in economic analyses of market-based approaches to light pollution control.[248]

Although some stakeholders strongly suggest that a single legally binding definition of light pollution could be made more easily understood by all relevant stakeholders, it is interesting to note here how broad a single legally binding definition of light pollution

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[246] The measurable indicators of prevention and control of outdoor light pollutants in main zoning for intrinsically dark-sky and district brightness areas may become a range of key health-relevant indicators of progress on sustainable urban lighting which includes measures for health burden from light pollution-related diseases, symptoms and injuries. For example, if a street light shines chronically shine into private bedroom windows, as is the intrusive light case at night when it shines its intrusive spillage, individuals may not be able to adapt to unacceptable levels of intrusive light at night. Measurable indicators may help gauge total street light brightness at night using predominantly the metric of acceptable eco-friendly darkness as an indicator. See Mackinnon, G., Hillier, T. A., Brandston, H. and Bray, C., *Heritage Lighting Master Plan for Old Town Toronto*, Toronto Heritage Preservation Services, 2011, p 94.

[247] Wisconsin State Legislature, *Chapter NR 400 Air Pollution Control Definitions*, available from http://docs.legis.wisconsin.gov/code/admin_code/nr/400/400.pdf accessed 29 April 2013.

[248] Hahn, R. and Stavins, R., *Economic Incentives for Environmental Protection: Integrating Theory and Practice*, Harvard University Kennedy School of Government, 1991, pp 1-16.

is, being any legally binding obligation that is intended to control light pollution for public environmental interests. This, and the different views of light pollution definitions, raises the question of whether such a single legally binding definition of light pollution could be effective and efficient.

Morgan-Taylor refers to a single legally binding definition of light pollution as a uniformity of light pollution definition that should '*cover the whole problem caused by light pollution, and is accepted by all interested parties, namely, policy makers and enforcers, lighting manufacturers, as well as business and domestic consumers*.'[249] This philosophy of defining legal light pollution terminology seems to be a direct consequence of uniformity of multi-disciplinary approaches for light pollution control deriving from scientific evidence and linkages between all interested parties and their responsibilities. This opportunity to structure a uniformity of light pollution definition based upon the multi-disciplinary approaches for light pollution control may prove to be both a strength and a weakness. This philosophy, like the duty to integrate multi-disciplinary or trans-disciplinary light pollution harm, is usually understood to comprise the integration of known harm as well as unknown harm. The whole problem may include both preventative and precautionary logics which may lead to greater flexibility of interpretation covering foreseen or unseen harms to all interested stakeholders. The strength of philosophy apparently welcomes linkages between all parties, problems and responsibilities as it raises awareness of both light pollution prevention and precaution.

Another main point about uniformity of a single legal light pollution definition is to develop a legally binding definition which better performs key environmental or dark-sky protection functions, such as: shielding of outdoor light fixtures and outdoor light direction control; use of energy efficiency sources of outdoor light; curfew hours in determining planning (as explained in Chapter 5). Legislators, policy makers, and other light industrial stakeholders may apply a legal definition to identify connections which will determine how unacceptable risks to human health and the night environment are

[249] Morgan-Taylor, M., *The Regulation of Light Pollution in Europe*, available from http://sllp.org/bbs/data/file/csheb_Symposium/1226372677_AkGhuFpH_02_Martin_Morgan_Taylor_paper.pdf accessed 29 April 2013.

mitigated by establishing regulatory functions for light pollution control that lay within the extent of defined contexts of non-environmentally friendly or inappropriate light. For example, it is necessary for the environmental or astronomical authorities to specify a single legal definition to which a single legal definition of light pollution must be applied or interpreted to comply with the regulatory functions for light pollution control.

However, there is a challenging question as to whether a single legally binding definition of light pollution should be regulated, or whether they would be better regulated within a variety of sub-definitions of light pollution, especially reflecting the astronomical and ecological risks they pose to any particular group of light pollution interests. On the basis of comparativeness of stakeholders, with several groups of light pollution stakeholders and with others who have not been affected as explained in Chapter 2, this research analysed that there are many special risk factors and other relevant impacts on non-environmentally friendly lighting practices. This means that some stakeholders (e.g. professional astronomers, nocturnal wildlife and night workers) might be more likely to suffer from non-environmentally friendly or unnecessary light than others. It could be argued that a variety of sub-definitions of light pollution is needed for specific control purposes or specific impacts on any institutions that may be subject to the different minimum legal lighting standards and level of outdoor brightness (e.g. astronomical light pollution, nocturnal light pollution and night-working-hours light pollution).

Although this research adds meaningful academic debate around a single legally binding definition of light pollution and a variety of sub-definitions of light pollution, this research strongly considers that legislators, policy makers, and other light industrial stakeholders should provide a forward-looking view into how a single legally binding definition of light pollution can be uniformly integrated with classification, characterisation, measurement and remediation across the English jurisdiction. In relation to the first of the concerns of awareness of public environmental interests noted above, this research acknowledges that those legislators, policy makers, and other light industrial stakeholders who can take an integrated knowledge of light pollution control through uniformity of a single legal definition of light pollution across all stakeholders

should be in a stronger position to identify and respond to all light pollution risks, through integration of the multi-disciplinary or trans-disciplinary light pollution harms.

Therefore, England may term a single light pollution definition in ways that might avoid some of the legal problems that have occurred elsewhere for controlling all aspects of light pollution. Focus on such a legal definition of light pollution may be part of the effort to ensure that light pollution control is supportive of environmental pollution control goals as further discussed in Chapter 8 and 9.

4.1.2 Light pollution definitions in soft laws

Because of widespread light pollution problems in the US, the Model Lighting Ordinance (MLO) establishes integrated outdoor light pollution control and gives guidance for national and local authorities' lighting practices[250], but the problem is that the light pollution definition is fragmented and unclear.[251] Although the light pollution definition of the MLO currently provides a good balance of night environment protection, the definition of light pollution is unclear and uncertain.

The Illuminating Engineering Society (IES) and International Dark Sky Association (IDA) defined light pollution as "*Any adverse effect of artificial light including, but not limited to, glare, light trespass, sky glow, energy waste, compromised safety and security, and impacts on the nocturnal environment.*"[252] So, under the MLO, the national and local governments may be non-legally bound to ensuring that their authorities have strong, clear and cost-effective environmental regulations that address the risk of lighting activities and that national and local regulatory frameworks remain effective and appropriate in the face of good lighting practice. The light pollution

[250] A basic aspect of the Model Lighting Ordinance (MLO), currently under public review, divides lighting practices into environmental zones for exterior lighting control. See International Dark-Sky Association, 'A Classification System for Lighting Zones', *Specifier Bulletin for Dark Sky Associations*, 2009 2 (1), p 2.

[251] Similarly, some excessive or obtrusive lighting is unlikely to conform to the specific legal definition of each premises in English jurisdiction, and so will probably escape environmental liability. See Morgan-Taylor, M., 'Light Pollution and the Law', *BBC Sky at Night*, 2006 January, available from http://www.astro.org.uk/lightpol/BBC_SkyatNight_lpol.pdf accessed 29 April 2013.

[252] Illuminating Engineering Society & International Dark Sky Association, *Joint IDA - IES Model Lighting Ordinance (MLO) with user's guide*, Illuminating Engineering Society, June 2011, p 36.

definition of the IES and IDA may be of assistance to the US's national and local authorities for the protection of the environment. However, in a wide range of light pollution context, the light pollution definition of the IES and IDA does not provide clarity and certainty for all aspects of light pollution control. The IES and IDA have not anticipated their existing environmental and planning regulation model in which the legal contexts cannot operate with the practices considered in all contexts of planning applications and ongoing environmental practices.

The light pollution definition of the IES and IDA is a particularly narrower notion than the light pollution for complex environmental problems. The complexity of socio-environmental problems relating to light pollution harms are difficult to describe clearly because some light pollution problems are unpredictable and hard to identify and analyses with the linkage between a legal definition of light pollution and many remarkable environmental problems.[253] For example, the environmental approach of the IES and IDA's definition does not deal in terms of environmental liability of lighting pollutants who interfere unduly with wildlife and habitants.[254] The increased complexity of light pollution problems associated with wildlife conservation[255] is highlighting problems with how the US local authorities create light pollution frameworks where their regulatory enforcement derive from local governments.[256]

The Model Lighting Ordinance (MLO) of the IES and IDA is not a universally agreed set of non-negotiable standards and obligations for local, national and international jurisdictions. These basic standards of the MLO do not set minimum levels of light

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[253] Brassoulis, H., 'Complex Environment Problems and the Quest for Policy Integration', in Brassoulis, H. (eds). *Policy Integration for Complex Environmental Problems*, 2005, pp 1-49.

[254] Gregory, M. *Conservation Law in the Countryside*, Tolley Publishing, 1994, pp 96-125.

[255] In absence of specific light pollution definitions in international and domestic laws, it was difficult to standardise and harmonise international and European light pollution frameworks in different countries and different jurisdictions. See Klemm, C. D., IUCN Environmental Policy and Law Paper Number 24 Wild Plant Conservation and the Law , International Union for Conservation of Nature and Natural Resources & World Wide Fund for Nature, 1990, pp 11-15.

[256] The effects of these two kinds of lights on the foraging behaviour of Santa Rosa beach mice (Peromyscus polionotus leucocephalus) was formerly investigated by American scientists which introduction of artificial light into wildlife habitat represents a rapidly expanding form of human encroachment, particularly in coastal systems. See Bird, B., Lyn, B. & Miller, D. L. 'Effect of Coastal Lighting on Foraging Behaviour of Beach Mice', *Conservation Biology*, 2004 18 (5), pp1435-1439.

pollution precaution and protection that should be respected by local, national and international governments. They are not founded on respect for the US's local and national obligation. Additionally the MLO is not the first legally binding international instrument to incorporate the full range of light pollution control for both international and national jurisdictions. It does not make sure that international bodies and national governments officially recognised[257] that the emergence of human-produced light pollution indeed influences framework formation and implementation procedures at international and domestic levels.

Growing evidence of light pollution problems relating to environmental degradation demonstrates that excessive or obtrusive lighting from premises is not only local but has taken on national, international and even global dimensions.[258] There have been many growing concerns that lights on at night can worsen environmental conditions for the global nocturnal environment and interfere with the natural dark-sky landscape. Therefore, the effective response to light pollution problems should require legal solutions; relying on regulatory mechanisms to address light pollution issues will not suffice. For example, recently, there have been signs of an enlightened approach on legal challenges of European light pollution issues.[259] The European Union decision-makers refer to the fact that incorrectly set excessive or obtrusive lighting can cause light pollution in European Countries.[260]

Consideration[261] of preliminary environmental problems concerning reparation for

[257] Economy, C. E. & Schreurs, M. A., 'Domestic and international linkages in environmental politics', in Economy, C. E. & Schreurs, M. A. (eds). *Cambridge Studies in International Relations: 54 The Internationalization of Environmental Protection*, Cambridge University Press, 1997, pp 1-18.

[258] Lomas, O., *Frontiers of Environmental Law*, Chancery Law Publishing, 1991, p2.

[259] Raine, H., et al. *Light pollution and its effect on Yelkouan Shearwaters in Malta; causes and solutions*, EU LIFE Yelkouan Shearwater Project, December 2007, pp 50-51.

[260] Cinzano, P., Falchi, F. & Elvidge, C.D. 'The first World Atlas of the artificial night sky brightness', *Monthly Notices of the Royal Astronomical Society*, 2001 328 (3), 689–707.

[261] The legal definitions of light pollution should indentify a number of environmental questions to which international and national frameworks will be required to provide potential solutions to environmental issues, for example, economic values of light pollution control, environmental harms and long-term consequences for light pollution monitoring. See Boyle, A. 'Reparation for Environmental Damage in International Law: Some Preliminary Problems', in Alan, B. & Bowman, M. (eds). *Environmental Damage in International and Comparative Law Problems of Definition and Valuation*, Oxford University Press, 2001, pp 2-15.

environmental damage in national and international law are likely to arise where new forms of variability in excessive or obtrusive lights are widely generated by modern techniques of illuminating engineering and lighting architecture design. On the other hand, there are no international and national jurisdictions where the laws set out proposals to provide a clearer legal definition of light pollution, by which we mean the scope of protection they afford.

As regards the lack of certain legal definition of light pollution, in order to obtain clarity as to these legal points it is useful to distinguish between a clear definition of light pollution and multi-level forms of light pollution control which the legal definition should effect. For example, in order to tackle light pollution problems from local and regional areas, national governments need to find ways to effectively decentralise enabling functions for light pollution control.[262] Devolution of environmental management power from national to local governments offers the opportunity to tackle light pollution problems in many local jurisdictions. National governments, thereby, may need to adequately address specific legal definitions of light pollution which include various conditions leading to successful decentralised light pollution control in domestic jurisdictions.

Similarly, international environmental laws generally consist of the set of international regulatory frameworks of various applications dealing with the conduct of states and of international bodies in their international relations, and contain many provisions which include key elements of sustainable pollution control and responsibilities,[263] for example, International Protocols, Treaties, and Conventions. However, there is currently no specific international provision linked to light pollution control and matter, which commits its member parties by setting internationally binding targets. Although the decision-making procedure in international environmental bodies gives them formal legitimacy in energy decisions, via international agreements linked to the United

[262] Cistulli, V., *Trainning Material for Agricultural Planning 44: Environment in Decentralized Development - Economic and Institutional Issues, Food and Agriculture Organization of the United Nations*, 2002, available from http://www.fao.org/docrep/005/y4256e/y4256e05.htm#bm05 accessed 12 May 2013.

[263] Fitzmaurice, M., *Contemporary Issues in International Environmental Law*, Edward Elgar, 2009, pp 67-109.

Nations Framework Convention, in binding emission reduction targets, such as reducing the amount of electricity and providing safe and effective lighting levels for homes, streets and public buildings in the *Kyoto Protocol 1997*[264], this Protocol does not specifically aim to provide an overview of light pollution control.

Many EU environmental frameworks now require Member States to stipulate a high level of environmental protection and assessment of environmental quality.[265] The European light pollution issue, however, has not particularly been resolved because of a lack of precautionary[266] and preventive measures against light pollution. Even though lights in the wrong place at the wrong time from European countries' premises are combining to inflict ever more obvious damage to nature and humankind[267], the current European provisions do not provide the possibility for tackling light pollution in European level.

Likewise, one of the challenges of international and European jurisdictions is that they cannot make sure that their frameworks are enough to protect or prevent light pollution. This needs certainly to be accomplished in conceptual ways of legal grounds that functionally protect the night environment and effectively provide requirements for member states' light pollution control on when to intervene. Therefore, international and European legislative bodies should remove legal uncertainty from the lack of

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[264] Department of Trade and Industry, *Our energy future– creating a low carbon future*, Cm 5761, February 2003, p 42.

[265] Winter, G., 'Environmental Principle in Community Law', in *The European Convention and the Future of European Environmental Law Proceeding of the Avosetta Group of European Environmental Lawyers*, Europa Law Publishing, 2003, pp 3-24.

[266] The precautionary principle is now invoked by many regional convention instruments. In the EU, The Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora (Habitats Directive) does not manifestly incorporate the precautionary principle, but states that in the case of project likely to have a significant impact on a protected site '*competent national authorities shall agree to the plan or project only after having ascertained that it will not adversely affect the integrity of the site concerned*...'. See Article 6 of the Habitats Directive in Cooney, R. 'A long and winding road? Precaution from principle to practice in biodiversity conservation', in Fisher, E., Jones, J. & Schomberg, R., *Implementing the Precautionary Principle Perspectives and Prospects*, Edward Elgar, 2008, pp 225-226.

[267] Huseynov, R., *Noise and light pollution Report Committee on the Environment, Agriculture and Local and Regional Affairs*, Doc. 12179, March 2010, available from http://assembly.coe.int/ASP/Doc/XrefViewHTML.asp?FileID=12390&Language=EN accessed 13 May 2013.

specific international measures by international law reform relating to light pollution control. The formal written international and European laws might ensure that light pollution control measures contain all the necessary features so that light pollution emission becomes a national concern.

While it is clear by now that legally enforceable definitions of light pollution for the purposes of international and European law are ambiguous where international jurisdictions do not set out how more effectively light pollution control is perceived, the next question that arises is: how should official written light pollution definitions in international and European jurisdictions be?

The aspects of international environmental frameworks permit, at least indirectly, the current legal aspects of national and local pollution control. They may provide the primary concepts for pollution assessment and control, on a national and local level, for example, the doctrines of statutory nuisance based upon written frameworks in English common law jurisdiction[268] and the polluter pays principle based upon written environmental code laws in German civil law jurisdiction.[269]

If it is possible to define specific light pollution terms in order to comply with all of the lighting requirement and standardisation, foreseeable harms from excessive or intrusive light pollution might be identified by the prevailing regulatory approach and environmental justice movement.[270] Lack of the most appropriate definition of light pollution is still being challenged by international law dimension where, for example, the international environmental regulations have not particularly established specific terms of light pollution in their jurisdictions. There are gaps, fragments and loopholes in

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[268] Eagle, S. J., *The Role of the Common Law in Defining and Protection the Environment: A Prolegomenon George Mason University Law and Economics Research Paper Series 08-16*, George Mason University, 2008, pp 1-43.

[269] Wirl, F. & Huber, C., *Strict Liability (Pollution Pays Principles) Versus Injunctions Under Aysmmetric Information*, Otto-von-Guericke University of Magdeburg & Vienna University of Technology, November 1999, pp 1-27.

[270] Scott, N. D., 'Confronting Chronic Pollution: A Socio-Legal Analysis of Risk and Precaution' , *Osgoode Hall Journal, Special Issue on Environmental Law*,2008 46 (2), pp 293-343, available from http://www.ohlj.ca/english/documents/OHLJ46-2_Scott_ConfrontingChronicPollution.pdf accessed 16 May 2013.

international and national environmental law where light pollution definitions, such as the legal definition of regional or global agreements, would set out a series of guiding definitions that apply to national or municipal jurisdictions for better light pollution control towards an integrated lighting governing practice. It would be become customary to just attach an annex and glossary of light pollution definitions in lighting governing bodies' reports and government publications, including research papers.

Not only will scientists, engineers and architects continue to differ among themselves on how to rank pollutants by virtue of their dangerous and toxic properties[271], but lawyers should also focus on specific identification of light pollution definitions in their jurisdictions. On the other hand, for legal definitions of light pollution to be effectively amalgamated and upheld in national laws, there must be legal certainty of how legal definitions of light pollution apply to different jurisdictions and in different situations. As a result, there is a lack of legal certainty and clarity which threatens light pollution from both international and national lighting premises.

An integrated definition of light pollution should be officially adopted by regional, national and local jurisdictions. This is the best way to ensure that the terms and techniques of light pollution control are successful given continued existence of mankind under very complex conditions of the modern invention and widespread use of artificial light. This recommendation is based on the view that, while this research recognises that such a standard of a single definition of light pollution should be officially established, it provides that there would have to be a clear single definition of light pollution and it will be possible simply to extend the definition of light pollution to include all aspects of light pollution.

Therefore, this Chapter also considers the basic question of why it might be thought necessary to look at how a single definition of light pollution is defined in English statutory law. English law should, in respect of multidisciplinary approaches for light pollution control and sustainable energy efficiency, be used only in so far as it is necessary to bring together legal awareness about integrated terminology from a wide

[271] Baros, J. & Johnston, D. M., *The International Law of Pollution*, Collier Macmillan Publishers, 1972 , pp 3-6.

range of light pollution concerns and only if a single unified definition of light pollution identifies the legal contexts of light pollution as being fundamental to the sustainable delivery of integrated control and better long term outcomes for sustainable lighting practices.

Of course, there are some previous studies that are intended to give a set of remarkable decisions about how a single unified definition of light pollution needs to function and what it might need to be much clearer. There is no fixed solution or right answer to a couple of questions, but the critical analysis of previous studies becomes more important when unification of the regulatory terms upon which light pollution is conducted is a separate issue from other pollutants.

In 2004, Morgan-Taylor & Hughes previously defined a single legal definition of light pollution according to a mixture of all or some or one of the following non-environmentally friendly lighting factors: '*every form of artificial light which shines outside the areas it serves to illuminate*' and '*light which is directed above the horizontal into the night time sky, or which creates glare, or other nuisance*'.[272] Again, in 2005, they also suggest the following as a working legal definition of light pollution upon which to base both issues: '*every form of artificial light which shines outside the areas it serves to illuminate, including light which is directed above the horizontal into the night time sky, or which creates glare, or other nuisance*'.[273] In 2006, Morgan-Taylor analytically explained why an artificial statutory nuisance has been flagged up as an environmental issue for all legislators and policy makers, but that this may lead to an overlap with a couple of previous contexts. The main purpose of this definition , which was designed to suggest that the DEFRA should adopt a statutory definition of light pollution, was to separate the specific legal aspects of artificial light nuisance in the *Clean Neighbourhoods and Environment Act 2005* from the general legal aspects of general statutory nuisance in the *Environmental Protection Act 1990,* in which light pollution might be defined as '*any form of artificial light which shines outside of the*

[272] Hughes, D. and Morgan-Taylor, M, 'And Can't Look up and See the Stars', *Journal of Environmental Law* 2004 16 (2), pp 215-232.

[273] Morgan-Taylor, M. & Mizon, B., 'Light pollution now subject to the criminal law of statutory nuisance', *Journal of the British Astronomical Association*, 2005 115 (3), pp 119-126.

area it is intended to illuminate, including light that is directed above the horizontal into the night sky creating skyglow (which blocks out the night time stars) or which creates a danger by glare', to review the absence of statutory definition of light pollution in English legal system.[274] However, in 2014, Morgan-Taylor calls for changes of multi-disciplinary expression of light pollution in the way all countries in Europe may be adapting to various interdisciplinary problems that has led to the formulation of a single legal definition of European light pollution. Although the main purpose of the 2014 paper is to examine the application of conflict of multi-disciplinary contexts of European light pollution literature, Morgan-Taylor recommended the contexts of '*a single definition encompassing the full spectrum of problems without creating some form of ambiguity*' should be based on multi-disciplinary assessments of current and future scientific risks from '*the broad range of negative effects that may be caused by artificial light at night*' (including glare, sky glow and obtrusive light) within cross-disciplinary approaches in order to understand both the inclusion of a cross-disciplinary awareness of light pollution risk and the effect of modernising a single legal definition of light pollution.[275]

These legal contexts of a single legal definition of light pollution are driving the search for better, more sustainable and more environmentally friendly ways to control light in the wrong place at the wrong time, sky glow, glare and light intrusiveness. They, including key elements of light pollution, some natures of non-environmentally friendly light and statutory nuisance, are covered in detail in the previous models of legal definitions of light pollution published in previous studies as mentioned above. Some effective contexts of light pollution, gained from a few models of a legal definition of light pollution, might likewise be expected, given that light pollution can be classified as glare, sky glow, intrusiveness of light and other relevant non-environmentally friendly form of light, involve harmful characters of excessive brightness and obtrusive

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[274] Morgan - Taylor, M., 'Light Pollution and Nuisance: The Enforcement Guidance for Light as a Statutory Nuisance', 2006 August, *Journal of Planning & Environmental Law*, available from http://www.britastro.org/dark-skies/pdfs/JPEL2006_08.pdf accessed 03 October 2013.

[275] Morgan - Taylor, M., 'Regulating Light Pollution in European' in Meier, J., Hasenöhrl, U., Krause, K. and Pottharst, M. (eds) *Urban Lighting, Light Pollution and Society*, Routledge, 2015, pp 162-163.

direction of light by non-environmentally friendly or inefficient use of outdoor light. They would also strengthen some current light pollution control actions, for example, full cut-off outdoor light shielding, switching off outdoor lights during the curfew hours and banning outdoor use of upward light beam displays, because key elements of light pollution in these model definitions could have been foreseen or prevented by scientists, legislators and policy makers.

However, the more generally asked question is ‘are these legal contexts in the previous models of a single legal definition effective?’ Additional questions remain about how necessary terms of a single legal definition of light pollution are set based on scientific information dealing with non-environmentally friendly or inappropriate light respectively and that a single definition of light pollution is primarily aimed at establishing an interesting way of getting people involved in understanding and tackling all aspects of light pollution easily.

This is not an argument against the previous ideas for unification of key elements of light pollution relating to regulatory control per se, but it does argue for allowing better multidisciplinary integration with the scientific concerns; see subsequent discussion below. The choice of a single legal definition of light pollution may effectively be whether to bear less restrictive contexts of a single definition of light pollution to better unify all effective contexts against several uncertain harms from possible future non-environmentally friendly lighting technology and a wide range of inappropriate socio-economic lighting action.

This research has given further consideration to these questions, especially whether it is necessary to carry out an analysis of all modern principles of light pollution originating from scientific evidence, where there may be the concerns raised by some scientific results. For example, some primary properties of artificial light (i.e. non-environmentally friendly wavelength of blue-rich artificial light at night and inappropriate electromagnetic spectrum of visible light) could have an adverse impact on the night environment by creating non-environmentally friendly conditions. Following the models of legal definitions, in which this research argued that a single

legal definition of light pollution should more widely reflect all new aspects of light pollution based on necessary scientific evidence, the Government may added all foreseen and unforeseen harms of non-environmentally friendly light to a specific statutory definition of light pollution.

Furthermore, public awareness through appropriate terminology of a single legal definition of light pollution can become an integral part of such an important initiative.[276] It might provide all relevant stakeholders with a single legal definition of light pollution that is easy to understand. Complex scientific terms of causes and effects of light pollution may be replaced with terms that children and adults can understand easily. While it could be realised, with adverse consequences for them, they would have awareness of rights to use outdoor light and environmental protection obligations wherever they are in their localities.

The specific light pollution definition will therefore depend upon the legislation that is being enforced; however previous models of a single legal definition of light pollution do not generally cover all aspects of light pollution and some of legal definitions may merely apply to or protect some aspects of light pollution. This research therefore recommends for the UK Government that light pollution should be defined as "*every form of artificial light in the wrong place at the wrong time which creates sky glow, glare, nuisance, and other relevant causes of environmental degradation including some properties of artificial light which emits non-environmentally friendly or inappropriate light.*"

This compact single legal definition of light pollution can provide an overview of the scope and context of regulatory terminology in future English law reform. Reasonable steps to enable all relevant stakeholders to understand their responsibilities and obligations as light polluters or practitioners can be taken by a series of precautionary and preventive contexts. For example, in the context of illuminating engineering, a single legal definition of light pollution may respond to the complexity of both certain

[276] Cabrido, C. and Joshi, G. R., *Air Pollution Teaching Toolkit Manual on how to teach air pollution to students of Grade 7–9*, Clean Air Network Nepal & Clean Energy Nepal, 2010, p 1.

and uncertain illuminating engineering problems, the paucity of scientific information and subsequent uncertainty about cause-effect relations, and the slow pace of public light pollution awareness and decision-making.[277] In particular, advocates of unifying terminology of a single legal definition of light pollution may assume that it is better to be cautious in the face of scientific uncertainty about a potential light property - such as non-environmentally friendly blue-rich white light wavelength from street lights and outdoor light premises[278] - which should be presumed to be harmful until proven otherwise.[279]

This means that a single legally binding definition of light pollution is about much more than an unofficial terminology of light pollution. It is a fundamental standardisation of protective or precautionary light pollution control rules, establishing a number of new legal contexts of which the emission of non-environmentally friendly or unacceptable light is banned by the rules, creating uniformity of light pollution contexts. This research definition also enhances the capacity to support necessary legal actions by the Government, and promote the environmental law knowledge to tackle all new challenges in preventing damage to and caring for the night environment and the dark-sky heritage for the benefit of present and future generations.

4.2 Guidance on matters to be taken into account in determining discussion relating to the definition of light pollution

International and national environmental frameworks have been progressively developing principles and instruments to take into account current environmental issues. Furthermore, they attempt to provide many responses to environmental issues by focusing on new multiple environmental problems. In order to promote the significant application of environmental law principles and legal instruments relating to light

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[277] Smith, C., 'The Precautionary Principle and Environmental Policy Science, Uncertainty, and Sustainability', 2000 (6) *International Journal of Occupational and Environmental Health*, available from http://www.sehn.org/pdf/ppep.pdf accessed 26 May 2013.

[278] Harvard Medical School, *Blue light has a dark side*, available from http://www.health.harvard.edu/staying-healthy/blue-light-has-a-dark-side accessed 26 May 2013.

[279] Weinhold, B., 'A Precautionary Tale: Mental Health and Risk Communication', 2005 (4) *Environmental Health Perspectives*, available from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1278507/ accessed 26 May 2013.

pollution in international and domestic jurisdictions, international environmental governing bodies should clearly define a specific definition of light pollution in an official intergovernmental document which is intended to be internationally binding with a primary stated purpose of preventing or managing light pollution impacts on environment, human health, and astronomical heritage. In fact, cooperation on terminology of most international environmental problems is currently recognised in that long-term threats to the global environment and energy are of international or public concerns to all states.[280]

Specific terminology of a legal light pollution definition is a main means for conveying information and knowledge in specialised light pollution problems. The necessity for terminology professionals to integrate the public concerns might strengthen the capacity to protect the environmental impacts, for example, a clarification of the light pollution definition. The national adoption of a legal definition from international agreements might make light pollution control easier for international and domestic jurisdictions. Furthermore, it is able to beneficially impose light pollution contexts which seek to provide a philosophy and exceptions[281] for lighting governance.

In regard to international and regional integration of light pollution control through laws, legal definition requirements from international and regional frameworks are the process of creating common standards of light pollution terms across regional and national jurisdictions. Each single definition might bring different national and local laws into harmonising line with each other, and is also common in lighting matters that affect the operation of the single lighting standardisation. Various different perspectives and views from each national and local light pollution jurisdiction may lead to different environmental impacts from problematic light pollution. For example, U.S. coastal jurisdictions set up their local laws to meet specific goals for marine turtle protection

[280] Cullet, P., *Differential Treatment in International Environmental Law*, Ashgate Publishing, 2003, p5.

[281] However, various exceptions in national and local light pollution frameworks are likely to be interpreted narrowly by national or domestic jurisdictions. Many restrictive interpretations of the existing provisional frameworks would normally need to be met inability to meet the full requirements of all aspects of light pollution, for example, Some of the lighting sources of light nuisance cannot be considered a statutory nuisance if they are some types premises require high levels of light for safety or security reasons under the Clean Neighbourhoods and Environment Act 2005.

from light pollution harms. The U.S. Coastal local authorities have passed local regulatory frameworks that require their local residents to turn off beachfront lights during turtle nesting season. These turtle frameworks contain unique environmental measures which have been designed to respond to specific coastal environmental problems in turtle hatching beach areas. So, light pollution problems might be recalled and recognised by different perspectives and views on light pollution matters.

Despite the fact that the obligation which result from these provisions is rather general and that many countries do not especially aim at the complete protection of problematic light pollution, these seems to be doubt that their legal definitions of light pollution should not be much more general or common in order to take such specific local action[282], but that they should be much more specific. However, more specific international light pollution frameworks cannot be currently found in recent international environmental instruments.

So, the international and regional legislation should be considered for the roles of the established practice of creating formal light pollution definitions through their environmental and planning frameworks which harmonise and integrate selected aspects of national and local law. This research paper suggests that international or regional environmental bodies should be specifically concerned with the main key question: what should the definition of light pollution be, or, what should the aspects of light pollution be within the scope of international and regional laws?

To answer this question, it is necessary to consider a number of possible causes of light pollution harms. Recent developments in legal definitions relating to light pollution from international and national jurisdictions could set the scene and provide a succinct summary of the aspects of light pollution, whilst their legal contexts in international and regional frameworks could also provide the precautionary and preventive methods for those who wish to explore official light pollution control further. The recent developments in light pollution law in global or regional contexts should be placed for ensuring public authorities and people are able to understand the basic aspects of light

[282] Kiss, A. C., *Survey of Current Developments in International Environmental Law IUCN Environmental Policy and Law Paper No 10*, 1976, pp 48-52.

pollution law. Similarly, many summaries of the key themes at play within that area of light pollution are the desire to make the appropriate lighting practices better for both international and regional jurisdictions because of the legal light pollution definitions available for future national and local adopting legislation.

As mention above, this research realises legal problems of light pollution may be treated differently from problematic contexts and situations will always be different[283], for example, different levels of light pollution protection and different public awareness about light pollution issues. However, there are obvious legal reasons why light pollution definitions should be subject to harmonised or integrated laws and why those international and regional environmental bodies should have to provide legal instruments for light pollution control.

As light pollution becomes increasingly negative in the planning environment, this means that the laws, especially with regard to different legal contexts in light pollution, should fulfil legal contexts where there are different regulatory approaches to human health and the environment. Scientific uncertainty, in fact, is leading to problems of environmental and planning management. It does not answer all technical light pollution terms where scientific evidence of light pollution is insufficient.[284] Although light pollution harms are often connected to uncertain scientific evidence[285], there are particular concerns that the potentially negative effects on the environment, human beings, and natural resources may be inconsistent with the high level of protection and prevention chosen by harmonised or integrated frameworks.

Therefore, legal definition requirements from international and regional frameworks should be carried out in coordination with uncertain scientific evidence on aspects of light pollution and certain precautionary approaches to the appraisal of light pollution

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[283] United Nations Educational, Scientific and Cultural Organization, *Educating for a Sustainable Future: Transdisciplinary Vision for Concerted Action*, United Nations Educational, Scientific and Cultural Organization EPD-97/CONF.401/CLD.l, 1997, p 24.

[284] Von Mlotke, K. 'The Vorsorgeprinzip in West German Environmental Policy' in Royal Commission of Environmental Pollution, *Best Practicable Environmental Option*, HMSO, 1988, Appendix 3.

[285] Commission of the European Communities, *Communication from the Commission on the precautionary principle*, Commission of the European Communities, 2000, p 10, available from http://ec.europa.eu/dgs/health_consumer/library/pub/pub07_en.pdf accessed 26 May 2013.

risk. The reliable light pollution definitions may lead to standardisation for concerted actions for light pollution control where there are no sustained patterns of legal awareness on light pollution problems. As a result, there is a good chance that national and local jurisdictions might take relevant substantial awareness. The identification of a light pollution definition is an important step towards recognising lighting practice quality through sustainable light pollution control. The national and local jurisdictions should be required to set their legal definitions of light pollution if the environment and human being may be at risk from light pollution in the future.

4.3 Future challenges for light pollution definition awareness

Legal definitions of light pollution remain narrow[286] and sufficiently restrictive.[287] Light pollution is generally described as artificial light allowed to illuminate, or pollute, areas not intended to be lit, notwithstanding general definitions of light pollution from lighting governing bodies or astronomical bodies which do not favour all terms for light pollution precaution and prevention. Many adverse effects of artificial light have been consistently defined as terms of light pollution, such as glare, light trespass, sky glow, energy waste, compromised safety and security, and impacts on the nocturnal environment. Controversially, this research argues that the legal definitions of light pollution should be flexible enough to encourage, rather than obstruct, the capability for light pollution control to mitigate all adverse effects of artificial light in the future. This legal challenge aims at raising awareness of the importance of clear light pollution definitions and that there are some challenges when trying to apply them in practice. For example, wrong colour light obscuring the true colours of specific objects or a cheap contemporary lighting fixture stuck into beautiful medieval era premise. [288] This challenge seems to have determined what kind of lighting should not be provided. It has

[286] Morgan-Taylor, M., *Global Approaches to Legislation for Light Pollution*, International Conference on Sustainable Lighting and Light Pollution, Seoul, Republic of Korea, 5-7 November 2014, available from http://www.sllp2014.org/light2014/data/Abstract_Martin_Morgan-Talyer.pdf accessed 26 May 2013.

[287] Morgan-Taylor, M., *Light Pollution, Nuisance and Planning Laws in the UK: The Legal Methods of Controlling Light Pollution in the UK*, 8th Sustainable Healthy Buildings Symposium, Seoul, Republic of Korea, 19 September 2012, pp 257-276.

[288] Gersil, K. N., *Fiber optics in architectural lighting: methods, design, and applications*, McGraw-Hill, 1999, pp 76-77.

been raised in many lighting practice controversies where there are wrong practical needs or poor performance during tasks.

Illuminating engineers or lighting designers should use every effort to avoid errors and to ensure that the contexts of lighting practices are complete. Because of this potential for light pollution harm, it is important that the law makers and all lighting practitioners may recognise and distinguish between light pollution concepts and understanding of their appropriate lighting practices.

Light pollution can be in the form of excessive or intrusive lights in the wrong place at the wrong time, inappropriate light practices, or non-environmentally friendly light usages, as examples. Therefore, the objective of legal light pollution definition should raise environmental awareness of the impact of light pollution on local authorities and government. A clear understanding of the application of the legal definition of light pollution is able to assist or encourage those working in public sectors and lighting governing bodies to maximise the use of legal requirements for light pollution control. To provide safe and effective light pollution controls, the legal definition of light pollution must be brought to public awareness or recognition in the right way as mention in Chapter 8 and 9.

Chapter 5: Key Elements of Environmental Law

Light pollution law may be based on key principles and concepts in environmental law (i.e., sustainable development principle, prevention principle, precaution principle, polluter pays principle and cooperation principle), and its regulatory mechanisms may involve legal instruments for different non-environmentally friendly lighting contexts, which gives rise to legally enforceable principles, or on non-legally enforceable aspects (such as soft law adopted by lighting professional bodies). Light pollution law may, however, involve a combination of different principles and concepts in environmental law: the national governments and environmental agencies may be subject to both statutory and market-based regulation (e.g. economic instruments can be used to cover the economic costs and losses of non-environmentally friendly lighting[289]) and key principles and concepts in environmental law may be incorporated in international, European, national and local regulatory frameworks and, therefore, are enforceable by relevant authoritative parties to those frameworks.

The environmental law principles, which could be interpreted and applied across the world instead of having to regulate for each jurisdiction, are widely recognised in several jurisdictions. They are also applied to different components in various areas of environmental and health risks to humans. Additionally, these principles reflect unforeseen risks and unforeseeable harms. They comprise not only regulatory functions and provision of public environmental interests but also principles that can lead to require environmental collaboration with the legal system. Environmental law principles are able to provide a legislative framework for incorporating the contexts of new comprehensive approaches for controlling key elements of pollution.[290] These

[289] While acknowledging the need for key environmental law principle approaches, this Chapter partially focuses on the potential for using polluter pays principle (PPP) – referred to as market-based instruments to address light pollution problems. They have a potentially important role to play in addressing light pollution, when used as part of a market-based strategy. See United Nations Environment Programme, *Guidelines on the Use of Market-based Instruments to Address the Problem of Marine Litter*, United Nations Environment Programme, 2009, pp 7-8.

[290] Stricter light pollution standards may be implemented by the international, European and national jurisdictions as a result of tightening basic norms, and then justified on the basis of the environmental law principles, are discussed more thoroughly below. See Jordan, A. and O' Riordan, T., *The Precautionary Principle in U.K. Environmental Law and Policy CSERGE Working Paper GEC 94-11*, Centre for Social and Economic Research on the Global Environment University of East Anglia and University College London, 1994, p 6.

principles, adopted by many national and local governments, support the use of statutory mechanisms and in some cases are strong drivers for the application of reforming modern pollution control frameworks.

From this perspective, environmentally friendly practices will be most likely to improve when the environmental law principles are reapplied with the preliminary focus on light pollution problems. This Chapter can help legislators and policy makers decide how best to apply key principles in the control of non-environmentally friendly and inefficiency lighting law.

This Chapter seeks to respond with critical analysis of five key principles of environmental law that are applied or codified in several international, European and national frameworks to which jurisdictions are committed or obligated. These principles generally represent the fundamental philosophy of light pollution control and are effective in delivering metrics, mechanisms and instruments that meet the acceptable degree of outdoor lighting with compromising human health and the night environment.

Chapter 5 and 6 are different. This Chapter analyses and evaluates five key principles and concepts in environmental law as fundamental norms are widely accepted.[291] Certain environmental norms contained in international, European and national frameworks, though declaratory in nature, can be expected to play a significant role in informing the written rules and statutory legislation, in particular those relating to the equitable and reasonable control of non-environmentally friendly lighting practices and the prevention of significant harm to human health and the night environment.[292] However, Chapter 6 especially assesses a number of current international frameworks that involve rules or standards with which international jurisdiction and its member states are meant to comply. It leads to the adoption of several fundamental norms of key environmental law principles designed to respond to and manage international and

[291] Rosencranz, A., Kibel, P., and Yurchak, K.D., *The Principles, Structure, and Implementation of International Environmental Law*, available from http://www.ucar.edu/communications/gcip/m3elaw/m3html.html accessed 25 February 2014.

[292] McIntyre, O., 'The Role of Customary Rules and Principles of International Environmental Law in the Protection of Shared International Freshwater Resources', *Natural Resources Journal*, 2006 46 (1), pp 157–210.

trans-boundary light pollution problems, and, while such intergovernmental organisation may intervene to prevent them, that is its objective.

The key environmental law principles will be divided into those referring to different factors influencing international, European and national jurisdictions as discussed more thoroughly in Chapter 6, 7 and 8. Finally, these principles may be intended to apply to all jurisdictions, from international level, to intergovernmental level, to regional level, to national level, and to local or municipal level involved in legal systems.

5.1 Introduction to the main aspects of environmental law

Many adverse impacts of unnecessary lights on human health, ecosystems and astronomical observatory heritage are brought about by inappropriate or non-environmentally friendly lighting emission. Therefore, taking legal action to reduce the effects of light pollution may provide opportunities to deliver further benefits to both light pollution control and environmental remediation.

The government and its environmental bodies are responsible for controlling the sources of inappropriate or excessive pollutants. They generally create new legal frameworks or change existing regulations so that many aspects of environmental law have been accepted as distinct parts of regulatory frameworks. A number of environmental laws include ensuring legal measures seek to provide light pollution control and take account of short and long-term environmental impacts of excessive or obtrusive lighting at local, regional, state and wider levels, including, for example, the effects of intrusiveness of lights. On the other hand, many regulatory gaps for exercising environmental and planning laws have not been reviewed with respect to all aspects of light pollution by legislators.

If legal aspects of light pollution control law are also subject to reform in the future, they will propose that it should be fit for all purposes of light pollution prevention. The legal requirements on light pollution apply to any upgrades or modifications made by the adaptation of environmental law theories and other mechanisms. However, when the reform of light pollution control law is challenged, the Government might be confronted with many difficult questions about how to adapt or apply many principles of

environmental and planning law in different contexts.

When any change to the light pollution legislation takes effect, specific laws should integrate light pollution control mechanisms[293] so that legal reform and its effects are

[293] Light pollution is an environmental problem across international and domestic jurisdictions and has caused various adverse impacts, in terms of human being, energy, astronomy and the environment. Existing legal mechanism for light pollution control generally purposes to reduce these negative impacts, not by wholly disposing light pollution, but by a thorough understanding of the negative effects and carefully minimise unnecessary or non-environmentally friendly lighting. It launches a number of mechanisms, as recommended in regulatory frameworks, which provides main environmental law aspects and advice on how to deal with light pollution. Firstly, the '*light source control*' mechanism for public sectors, manufacturers, businesses and consumers, and householders defines minimum standards of ethical duties and responsible behaviour which must be met by the relevant stakeholders of the light products commercialised or used in the course of their lighting installations and design, in line with the standardisation of light sources, based on the sustainable, precautionary and preventive approaches for reducing emissions of carbon dioxide and saving energy bill, for example the traditional inefficient light bulb has been being phased out in favour of low energy alternatives because standard watt incandescent light bulbs must effectively use less energy to meet minimum efficient standards. Secondly, the '*lighting practices*' mechanism in light pollution laws has been adopted by many jurisdiction in order to precaution or prevent unnecessary or inappropriate lights from excessive illuminating lights or misdirected lighting. It generally gains its legal aspects to enforce the lighting practices standardisation as well as the sustainable lighting approaches. For example, preventive approaches of the light pollution laws require that all outdoor light fixtures or installations be fully or partially shielded and provides the sustainable lighting conditions relating to curfew hours in determining planning applications. Thirdly, the '*designing and installing outdoor lighting*' mechanism in light pollution laws technically requires that outdoor lights must be designed to maximise energy conservation and minimise glare, sky glow and light spilling onto adjoining lighting premises and provide the minimum amount of lighting needed for its purpose though sustainable illuminating engineering techniques and ecological architectural lighting design. Next, the '*environmental zones for exterior lighting control*' measure are intended for controlling urban brightness areas and dark-sky preservation landscapes, and providing details for outdoor lighting properties or premises. This measure generally identifies urban brightness areas or landscapes where potential significant light pollution harms from unnecessary or non-environmentally friendly lighting exists. Finally, the '*market-based instruments*' implementing measure are applied relatively to light products as energy products for reducing emissions of carbon dioxide and saving energy. This mechanism generally offers a market incentive to environmentally friendly lighting product innovation and ecological commercial practices. It raises legal standards to encourage manufacturers, businesses, distributors and consumers to keep their light product improvement through the establishment of the environmentally friendly consumption and ecological production. However, in both short-term and long-term perspectives, other lighting measures could be taken that would usefully require an amendment of the existing legal mechanism under light pollution laws in a variety of jurisdictions because existing legal mechanism for light pollution control because many international and domestic jurisdictions are not fully reaping the benefits of all approaches of the environmental and planning laws. Existing legal measures for light pollution control give magnificent light pollution precaution and prevention, but also have areas where inadequacy of clarity can lead to diminish environmental appraisal approaches and slack in enforcing some aspects of light pollution. To strengthen alternative light pollution control mechanisms, this research will present new useful mechanisms to challenge light pollution issues. It has the potential to

managed in a way that is sustainable to lighting, and for related purposes of excessive or inappropriate lighting control. Across a wide range of environmental and planning law theories, this Chapter has been specially designed to introduce many clear legal aspects[294] of environmental and planning law through understanding of the way these legal principles have been developed and the future challenges they will face if a wide variety of principles of environmental and planning law, setting out minimum lighting requirements for the protection of dark-sky environment and ecological systems, are adopted by the Government.

This Chapter in particular raises important questions about the legal light pollution control. How are fundamental principles of environmental law significant enough to be acknowledged by all government and its environmental bodies regarding how well they protect the environment? What does the contribution of these fundamental principles add to the legal systems towards greater light pollution protection? Why does the UK deserve to accept the philosophy of applying precautionary, preventative, sustainability-based, controls to the emission of unnecessary or inappropriate outdoor light to the atmosphere and the night environment, in both direction and brightness?

5.2 Setting standards for light pollution control law

A number of different environmental protection requirements are normally designed to protect human well-being and the environment through the setting of prospective environmental standards where they set technical standards and specific measures, both at a general level and specific to different stakeholders.[295] Many frameworks have

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strengthen the significant links between previous mechanisms and alternative mechanisms while ensuring that future aspects of light pollution control are able to be pursued or refined through legal systems and their law reforms. See Turner, R. K., *Blinded by the Light: The Enforcement of Outdoor Municipal Lighting Ordinances in Texas*, Texas Municipal Courts Education Center, 2015, pp 1-10.

[294] Taking into consideration the differences in purposive analysis between Chapter 5 and Chapter 6, the analysis of Chapter 5 specifically impart some critical ideas in order to discuss an integrated choice of application of the key elements of environmental law. The Chapter 6 is provided focusing, in particular, on the comparison between the existing international frameworks to control light pollution harms, and on the interactions between several principles of environmental law and various existing international frameworks.

[295] Environment Agency, *Regulatory guidance series, No RGN 4 Setting standards for environmental protection GEHO0112BUKP-E-E Version 3*, Environment Agency, 2011, p 6.

required the Government to set environmental standards and enforce these standards[296], nevertheless there are many growing gaps between environmental harms and environmental standard-setting approaches.[297] Environmental law may be designed to fulfil the absence of environmental standards or the lack of existing environmental provisions. The critical questions when setting standards of environmental laws on light pollution control generally tend to be most often stated in terms of how legal aspects of light pollution control become domestic law and how the Government creates new regulatory requirements or changes existing frameworks.

While fundamental principles of environmental law are norms that are widely accepted by common and civil legal systems[298], they have not been identified as a necessary medium for ideals to find their way into concrete light pollution rules.[299] To show that these environmental law principles are balanced, thus, this research also shows that international, European and national jurisdictions have regulatory incentives to follow them. The principles will be recognised as important motivations behind public decision making in international, European and national law models. They will be applied to assist international, European and national jurisdiction in reforming and modernising their light pollution laws so as to take into account the particular features, mechanisms, incentives and needs of controlling key elements of light pollution.

Because there are no standard requirements for many areas of light pollution issues and because principles-based approaches to standard setting are unclear[300], this research especially suggests that legal approaches should provide useful guidance that focuses on fundamental principles of environmental and planning law addressed in the legal

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[296] Kaswan, A., 'Environmental Justice: Bridging the Gap between Environmental Laws and "Justice"', *The American University Law Review*, 1997, 44 (211), pp 211 - 300.

[297] Mackenzie, J., *Environmental law on first nations reserves: Bridging the regulatory gap*, British Columbia Department of Justice and British Columbia Ministry of Environment, 2013, p 17.

[298] University Corporation for Atmospheric Research, *Established Norms of International Environmental Law*, available from http://www.ucar.edu/communications/gcip/m3elaw/m3pdfc2.pdf accessed 25 February 2014.

[299] Verschuuren, J., 'Sustainable Development and the Nature of Environmental Legal Principle', *Potchefstroomse Elektroniese Regsblad*, 2009 1 (9), pp 209-261.

[300] Royal Commission on Environmental Pollution, *Environmental Standards and Public Values: A Summary of the Twenty-first Report of the Royal Commission on Environmental Pollution*, Her Majesty's Stationery Office, 2005, p 10-11.

standards, hereby increasing the need to apply necessary legal approaches in the situations not addressed. The legal instruments and other relevant approaches will be found in the following principles. These environmental law aspects designed to insert in to national or local regulatory instruments, and in particular minimum standards for light pollution control, must be construed as far as possible so as to adopt the purposes and ideas of them. While acknowledging the key principles of environmental law, this Chapter and its subheadings will ensure that common reference for all light control pollution stakeholders, as well as regulators, can promote compliance with these guiding principles in the near future.

5.3 Principle of sustainable development

To take into account significant developments in the field of long-term pollution control, with due regard to the roles of relevant intergovernmental bodies and pollutant governing bodies in promoting the adoption or implementation of legal aspects relating to environmental regulatory mechanisms[301], environmental and planning laws may provide a significant principle of environmental law and its instruments which address the intersections between economic, environmental and social law (including other relevant aspects), towards development that can last for the prospective usefulness of present and future generations.[302]

One of the most important disciplinary approaches of environmental and planning law is sustainable development. It is defined as '*development that meets the needs of the present without compromising the ability of future generations to meet their own needs*' under Agenda 21 of the *United Nations Conference on Environment and Development (Brundtland Commission) in 1992*.[303] Moreover, sustainability is also defined as '*a policy and strategy for continued economic and social development without detriment to*

[301] United Nations, *Report of the World Summit on Sustainable Development at Johannesburg, South Africa, 26 August- 4 September 2002 A/CONF.199/20*, United Nations, 2002, para 29, available from http://www.un.org/jsummit/html/documents/summit_docs/131302_wssd_report_reissued.pdf accessed 25 February 2014.

[302] Centre for International Sustainable Development Law, *What is Sustainable Development Law ?: A CISDL Concept Paper*, Centre for International Sustainable Development Law, 2005, pp 1-4.

[303] United Nations, *Report of the World Commission on Environment and Development: Our Common Future*, available from http://www.un-documents.net/our-common-future.pdf accessed 25 February 2014.

the environment and the natural resources on the quality of which continued activity and further development depend' for the purposes of the 5th Action Programme (5EAP).[304]

International and regional jurisdictions apply the principle of sustainable development when pursuing the three goals of economic, social and environmental implementation efforts.[305] These would apply when a number of environmental challenges arise from non-environmentally friendly production and excessive consumption patterns.[306] So, there is overwhelming support for the sustainable view that reform of light pollution control law will be needed in which the principle of sustainable development would fill many gaps in existing provisions. For example, legislative instruments, market-based mechanisms, horizontal supporting instruments and financial support mechanisms[307] may be involved or covered by the proposed legislation to ensure that lights are sustainably aligned, installed and used.

In this context, control of light pollution through sustainable development has been seen as a necessary approach of long-term activity to restrict environmental impacts from light pollution within acceptable bounds[308] while emission standards on the reasonable level of light pollutants and maximum allowance of illumination are designed to advance a common integrated approach towards sustainable light use. However, within the general limits of sustainable development approaches, the main concept of this sustainable light pollution control does imply limits, not absolute limits, but limitations imposed by the economic and social development on environmental resources and by the ability of the procedure to absorb the adverse impacts of outdoor lighting

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[304] European Communities, *Towards Sustainability: A European Community programme of policy and action in relation to the environment and sustainable development*, Official Journal of the European Communities, 1993 May, No C 138/7, p 23.

[305] Stookes, P., *A Practical Approach to Environmental Law*, 2nd edition, Oxford University Press, 2009, p 23.

[306] United Nations' Department of Economic and Social Affairs, *World Economic and Social Survey 2013 Sustainable Development Challenges E/2013/50/Rev. 1ST/ESA/344*, United Nations, 2013, p v.

[307] Sunkin, M., Ong, D. M. and Wight, R., *Sourcebook on Environmental Law*, 2nd edition, Cavendish Publishing, 2002, p 48-49.

[308] Panayotou, T., *Economic instruments for environmental management and sustainable development*, United National Environment Program, 1994, p 2.

activities.[309] Firstly, of course, as we have seen, "*sustainable development*" is widely defined, and includes other buzzwords such as "*sustainable ecology, sustainable economy, sustainable energy, sustainable markets, sustainable public finances, etc*".[310] However, it appears that the definition of "*sustainable light pollution control*" or other technical terms regarding sustainable control of light pollution have not been used in the provisions, with the result that light pollution control law cannot apply to all aspects of sustainable lighting or sustainable light pollution control when artificial light allowed to illuminate, or pollute, areas not intended to be lit has resulted in environmental problems in jurisdictions.

Secondly, the principle of sustainable development is usually interpreted in wide approaches, but '*narrow approaches to sustainable light pollution control*' perhaps disappear in any sustainable development perspectives in which environmental harms have occurred in many jurisdictions. This means the concept of sustainable development could not only ensure dark-sky preservation and night environment protection, but also the integration of regulatory measures on lighting governing practices in order to avoid undesirable barriers to light use – environmental protection balance. Again, the good balance between social development, economic development and environmental protection should not be ignored by the integration of these sustainable concepts. Nevertheless, different ways of integration emerge from them, depending on the environmental challenges of unsustainable light use which many jurisdictions face in the near future.

Next, it might be difficult to define the boundaries of what sustainable forms of light pollution control are. The '*conflicts between environmental issues and economic lighting interests and social lighting reasons*' are complex when the main problem is the wrongful lighting conduct of all non-environmentally friendly light production and

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[309] World Commission on Environment and Development, *Our Common Future*, Oxford University Press, 1987, p 8. and See Kates, R. W., Parris, T. and Leiserowitz, A. A., 'What is sustainable development?: Goals, indicators, values, and practice', *Environment: Science and Policy for Sustainable Development*, 2005, 3 (47), pp 8–21.

[310] European Academy of Sciences, *Limits to Sustainability: Sustainability, values & responsibility*, available from http://www.eurasc.org/docs/2010/GRT10%20-%20Declaration%20-%20FINAL2.pdf accessed 26 February 2014.

inappropriate lighting consumption. Even though a necessary sequence of outdoor lighting practices is designed to control outdoor lighting in a manner that will provide a more sustainable approach than what has been the conventional practice of lighting through many techniques and methods, differences in lighting practices would result from a number of economic and social factors. This means that if we are allowed to use outdoor light without necessarily lighting control in all economic and social circumstances and the Government fails to tackle defects in various steps of light pollution control, the principle of sustainable development would not be implemented for purposes connected with outdoor lighting practices. For example, Christmas or special events lights decoration and relevant lighting displays may attract travellers, visitors and shoppers. There is possibly an increase in the number of economic benefits and Christmas heritage conservation in local event society. By contrast, outdoor Christmas lights potentially give wasted light shining upward wherever possible which can also increase atmospheric light smog or sky glow.

Finally, the need for alternative light pollution control, such as sustainable light practices, is likely to increase to meet environmental challenges such as urban light growth, energy saving standard, climate change and population growth, but there may be difficulties in achieving light pollution control sustainably due to the lack of assessment of light pollution risks. Many regulatory frameworks governing lighting practices have not particularly required their environmental governing bodies and local authorities to assess or evaluate if all light uses and illumination technologies are a risk. Of course, many astronomical and environmental bodies have previously presented dark-sky and night environment maps which can be taken at international and domestic levels to improve the effectiveness of light pollution identification and protect dark-sky parks and semi-natural dark-sky areas from being damaged by light pollution, but risk management practices of light pollution do not become mandatory or compulsory approaches in many jurisdictions.

Following the practical adoption of the sustainable development principle, this would create legal binding practices between the Government, lighting governing bodies and other stakeholders where many elements of light pollution are able to harm people’s

habitat and their health. For the following positive reasons, including sustainable development content in laws may lead the Government to make sustainable restrictions on how people can use their lights sustainably and how the Government's lighting restrictions reasonably fit for sustainable light pollution control's purposes. However, the Government and its environment authorities could modernise sustainable laws for a regulatory framework of light pollution control to prevent and protect environmental harms so that non-environmentally friendly lights and its effects are sustainable managed in a way that is ecologically sustainable, and for related purposes as mentioned below.

5.4 Principle of prevention

Many national governments and their environmental governing bodies are conducting both informal and formal consultation on how to tackle light pollution, although the laws have not been carried out in all preventive approaches. Necessary preparedness of prevention has not apply to light pollution control in environmental and planning stage processes whereby environmental governing bodies and local authorities may undertake to prevent adverse impacts caused by excessive or obtrusive lighting in urban brightness areas as well as dark-sky preservation landscapes. In addition, people and lighting product consumers may be entitled to be informed about primary light pollution risks and preliminary brightness areas where potential significant light pollution risk exists. A people-oriented approach to environmental information rights is not fully incorporated into some national legal systems. A lack of significant duty to promote and raise awareness of the rights contained within warning of the light pollution harms as well as concerns of the lighting product consumer knowledge can lead to various calls for more clearly defined light pollution prevention.

The principle of prevention generally pursues environmental activity and allows action to be taken to protect the environment at an early stage. It should be referred apart from the duty of supranational bodies, states and local authorities to avoid environmental or ecological damages.[311] Many international environmental frameworks establish a

[311] Sands, P., *Principles of International Environmental Law*, 2nd edition, Cambridge University Press,

foundation of the prevention principle and it was proposed in the *Declaration of the United Nations Conference on the Human Environment (Stockholm Declaration) 1972* as the obligation of nations[312] '*to ensure that activities within their jurisdiction or control do not cause damage to the environment of other states or of areas beyond the limits of national jurisdiction*'.[313] Again, legal aspects of preventive approaches were set up in Article 30 of the *United Nations General Assembly resolution 3281 in 1974* as the international obligations. This provision repeatedly provides, inter alia, that '*All States have the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction*'.[314]

To introduce a national responsibility for ensuring that the environmental pollution control for health and safety had been performed, domestic laws should meet both the standards set in these international environmental frameworks and the legal aspects of international environmental law. This would mean that environmental and planning laws in domestic jurisdictions would authorise environmental governing bodies and their local authorities to set best practicable standards of light pollution prevention and to conduct an assessment of excessive or obtrusive lighting. The legal obligations are therefore important in addressing the context of the responsibility to control, assess and remedy inappropriate or unnecessary lighting and the consequent degree of lighting levels permitted in a lighting circumstance.

Domestic environmental and planning legislation could set out in detail the regulatory frameworks base for its light pollution proposals alongside legal advice on the risk to

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2003, p 246.

[312] Trouwborst, A., 'Prevention, precaution, logic and law: The relationship between the precautionary principle and the preventative principle in international law and associated questions', 2009 (2), *Erasmus Law Review*, available from http://www.erasmuslawreview.nl/files/Trouwborst_-_issue_Pieterman_d.d._27_augustus.pdf accessed 5 March 2014.

[313] See United Nations Environment Programme, *Declaration of the United Nations Conference on the Human Environment*, available from http://www.unep.org/Documents.Multilingual/Default.asp?documentid=97&articleid=1503 accessed 5 March 2014.

[314] United Nations Conference on Trade and Development, *International Investment Instruments: A Compendium Volume XII*, United Nations, 2003, pp 57-70.

inappropriate or unnecessary lighting. This research reasonably considers that light pollution could be mitigated or prevented at the source whenever feasible. Preventive approaches would therefore be applied to all light pollution-generating activities, including how market-based activities or economic incentives could give rise to financial proceedings where financial regulations give polluters an incentive to reduce light pollution.

In consequence, the laws for light pollution prevention would require relevant stakeholders to carry out preventive schemes or programmes to assess or identify the inappropriate or non-environmentally friendly lights at risk of harmful light pollution. For example, the provisions of light pollution law could authorise schemes or programmes to reduce light pollution harms. They may particularly require officials or relevant stakeholders to carry out a preliminary light pollution assessment to identify the urban brightness areas and dark-sky protection landscapes at risk of light pollution. For such brightness areas or dark-sky landscapes they would then need to draw up light pollution maps and set up plans focused on prevention of light pollution impacts.

Stakeholders who understand their duties of light pollution prevention could play statutory or mandatory roles in driving light pollution control approaches because they have a particular responsibility to prevent brightness areas or intrinsic dark landscapes for the wider range of light pollution control reasons. For these stakeholders need both effective statutory approaches and a number of strong but simple provisions of light pollution control law that can be effectively enforced by the national Government and local authorities. Poorly understood or unclear environmental and planning laws for light pollution prevention may lead to many barriers at all levels. They would be mitigated by removing unnecessary burdens and restrictions which limit the legal approaches of light pollution prevention. In addition, this research also proposes volunteering bodies which play important roles, helping the national government, environmental governing bodies and local authorities make the light pollution prevention schemes or dark-sky preservation campaigns better for communities. Voluntary support for light pollution prevention will be committed to recruiting individuals where outdoor lighting becomes inefficient, inappropriate and unnecessary

in their areas.

5.5 Precautionary principle

The precautionary principle generally means that risks to environmental harms and health hazards should be expected and that they would be controlled before the obviousness of damage, even if scientific knowledge or information of the risks is insufficient. It has been significantly influential amongst legislators' policymaking decisions concerned about the possibility of major human impacts and ecological effects on the global and domestic environment.[315]

Principle 15 of the *Rio Declaration on Environment and Development of 1992* stated that '*in order to protect the environment, the precautionary approach shall be widely applied by States according to their capability. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation*'.[316] Again, Principle 15 of the *Rio Declaration on Environment and Development of 1992* is reproduced in similar contexts of precaution in the *Convention of Biological Diversity 1992* that '*...Noting also that where there is a threat of significant reduction or loss of biological diversity, lack of full scientific certainty should not be used as a reason for postponing measures to avoid or minimise such a threat...*'. [317]

Similarly, Article 3 of the *United Nations Framework Convention on Climate Change 1992*, which commits its Parties by setting internationally binding emission reduction targets, states that '*The Parties should take precautionary measures to anticipate, prevent or minimize the causes of climate change and mitigate its adverse effects. Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing such measures, taking into*

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[315] Gardiner, S.M., 'A Core Precautionary Principle', *Journal of Political Philosophy*, 2006, 1 (14), pp 33-60.

[316] World Health Organisation, 'Dealing with uncertainty – how can the precautionary principle help protect the future of our children?' in Martuzzi, M. and Tickner, A., (eds), *The precautionary principle: protecting public health, the environment and the future of our children*, World Health Organisation, 2004, pp 15-30.

[317] United Nations, *Convention on Biological Diversity*, United Nations, 1992, p 1.

account that policies and measures to deal with climate change should be cost-effective so as to ensure global benefits at the lowest possible cost. To achieve this, such policies and measures should take into account different socio-economic contexts, be comprehensive, cover all relevant sources, sinks and reservoirs of greenhouse gases and adaptation, and comprise all economic sectors. Efforts to address climate change may be carried out cooperatively by interested Parties'.[318]

In addition, at European level, the Commission of the European Communities refers to European contexts of the precautionary principle in communication from the Commission on the precautionary principle 2000: '*The precautionary principle applies where scientific evidence is insufficient, in conclusive or uncertain and preliminary scientific evaluation indicates that that there are reasonable grounds for concern that the potentially dangerous effects on the environment, human, animal or plant health may be inconsistent with the high level of protection chosen by the EU*'.[319]

The precautionary approaches of light pollution would follow the substance of the terminology in international frameworks by stating that a practical approach of precaution is necessary and that inadequacy of full scientific certainty shall not be used as a reason for postponing measures to prevent negative environmental impacts where there are threats of serious or irreversible damage. By contrast, we could argue that it would be too uncertain to introduce a precautionary approach specifically for all lighting circumstances as the scope may be difficult to define and it could represent a departure from the current approach of domestic law, although a useful light pollution control law would sustainably apply to all kinds of previous, current and future light pollution harms.

The precautionary principle applied to light pollution control would provide an approach of precautionary principle that is not always easy to understand. There are complexities arising from an understanding of the difference between the prevention

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[318] United Nations, *United Nations Framework Convention on Climate Change*, United Nations, 1992, p 4.

[319] Commission of the European Communities, *Communication from the Commission on the precautionary principle*, Commission of the European Communities, 2000, p 8.

principle and precautionary principle.[320] This complexity may be an issue for implementation of aspects of light pollution control, which carried out both principles into each stage process whereby each stage process is to include different measures to manage the uncertainty harms or to reduce the probability of light pollution risks.[321] To avoid the confusion between the prevention principle and precautionary principle, the difference between preventive approaches and precautionary approaches is basically related to the difference between environmental risk and scientific uncertainty.[322] Preventive approaches are the response to well known risks to light pollution impacts. When the risks associated with light pollution effects are informatively known by primary concerns of light pollution within jurisdictions, legal measures are to be taken to assess and manage the reduction of risks to astronomical observation, human health, and environmental impacts. The purpose of preventive approaches is to mitigate the well known risks that light pollution pose to astronomical heritage, human health, the environment, and energy economics. On the other hand, precautionary approaches inherently deal with risks where scientific uncertainty is inherent in understanding the potential for light pollution harms or where regulatory frameworks should be taken to prevent harm to astronomical heritage, human health, the environment, and energy economics, even if scientific evidence is unverifiable.

Many precautionary approaches are in effect light pollution harms by approaching uncertain harms from artificial lighting in the precautionary stage process. Where unforeseen or unexpected harms of light pollution exist[323], legal systems could develop the specific implications of precaution in light pollution control law for domestic and local jurisdictions. They are useful instruments for a more procedural response to

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[320] Renn, O. and Stirling, A., *The precautionary principle: A new paradigm for risk management and participation*, institut du développement durable et des relations internationales, 2004, p 2.

[321] Benaroya, F. and Kosciusko-Morizet, N., *Making sense of the precautionary principle*, European Trade Study Group (ETSG) 2001 Conference, Brussels, 14-16 September 2001, p 2.

[322] Trouwborst, A., 'Prevention, Precaution, Logic and Law: The Relationship between the Precautionary Principle and the Preventative Principle in International Law and Associated Questions' *Erasmus Law Review*, 2009, 2 (2), pp 105-127.

[323] Gehring, M. W. and Segger, M. C., *Precaution in World Trade Law: The Precautionary Principle and its Implications for the World Trade Organization*, available from http://cisdl.org/public/docs/news/brief_precaution_trade.pdf accessed 11 March 2014.

address judicial decision-making surrounding uncertainties of light pollution development. Decision-making processes of light pollution precaution should endorse an approach to risk management and in particular should proceed to the adoption of appropriate precautionary approaches even when the economic costs of applying the precautionary principle are a genuine concern[324], but these costs may be balanced by the threat of irreversible harm as already mentioned in the next subheading.

5.6 Polluter pays principle

In order to provide pollution control, legislators and policy makers generally introduce several regulatory approaches used in environmental law making, which have been adopted by domestic regulatory frameworks. Lawyers and policy makers not only introduce general environmental measures to apply in several aspects of pollution control, but also address the measures relating to incentives for polluters to reduce pollution beyond what is required to reach level of compliance with environmental standards or requirements. For these reasons, a simplified measure of market-based incentive approaches can be confidently used to allow polluters (such as manufacturers, importers, distributor, seller and consumers) to address the environmental challenges posed by increasing complementary approaches of reducing potential harms to the environment where pollution is to be borne by the originators.

The polluter pays principle, as a measure of market-based incentive approaches, is used for allocating costs of pollution prevention and control measures to encourage rational use of scarce environmental resources and to avoid distortions in international trade and investment.[325] The Organisation for Economic Co-operation and Development originally defines this principle as that '*the polluter should bear the expenses of carrying out the above-mentioned measures decided by public authorities to ensure that the environment is in an acceptable state*'. Similarly, the United Nations Environment

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[324] Shaw, S. and Schwartz, R., *UNU-IAS Report Trading Precaution: The Precautionary Principle and the WTO United*, United Nations University, 2005, p 10.

[325] Organisation for Economic Co-operation and Development, *Recommendation of the Council on Guiding Principles concerning International Economic Aspects of Environmental Policies*, available from http://acts.oecd.org/Instruments/ShowInstrumentView.aspx?InstrumentID=4&Lang=en&Book=False accessed 13 March 2014.

Programme (UNEP) offers specifically explanations[326] on the term of this principle in that '*The 'polluter pays principle' states that whoever is responsible for damage to the environment should bear the costs associated with it*'.[327]

Definitions have been applied with flexibility on a jurisdiction-by-jurisdiction basis to support the reasonable linkages between using market-based instruments to address harmful pollution and as a reflection of the regulatory response to pollution in jurisdictions. While most of these requirements targeted the displacement of pollution, there are potential approaches of market-based instruments that can more precisely target some of the more damaging forms of pollution, for example, environmental charges, taxes, fines, banning products and deposit-refund programmes have become commonplace and understood.[328]

To promote the reduction of light pollution, this subheading critically indicates what can be learned from what potential there is to use the polluter pays principle. This principle has become widely accepted as the legal aspects for internalising environmental externalities that assigns responsibility for addressing pollution to the polluters. It ensures that the polluter to take purposive responsibilities and respective capabilities to reduce pollution when polluters are emitting inappropriate or unnecessary lights into the environment. To provide an incentive to change people's lighting consumption behaviour, as well as to raise revenue, taxes or charges for light pollution and compensation for adverse impacts have become commonplace and are understood by polluters. In addition to legal requirements for energy-related behaviour and lighting consumption behaviour, a useful function of this principle is to internalise the environmental costs borne by the public authorities for light pollution control when encouraging polluters to reduce their emissions instead of being content to pay

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[326] Cordato, R. E., *The Polluter Pays Principle: A Proper Guide for Environmental Policy*, Institute for Research on the Economics of Taxation, 2001, p 1.

[327] United Nations Environmental Programme, *Taking Action: An Environmental Guide for You and Your Community*, United Nations Environmental Programme, 1995, p 3.

[328] Ten Brink, P. et al., *Guidelines on the Use of Market-based Instruments to Address the Problem of Marine Litter*, Institute for European Environmental Policy, 2009, p 8.

charges.[329]

In discussing the potential approaches of the polluter pays principle to light pollution control, this principle usefully influences environmental outcomes by controlling lighting emission products and limiting the discharge of light pollutants, and by restricting outdoor lighting activities to specific lighting times (conditions relating to curfew hours in determining planning) or brightness areas (environmental zoning for exterior lighting control within planning development), but there are usually a number of limits as to how the polluter pays principle can particularly provide financial regulatory incentives to minimise light pollution emissions or achieve light pollution control outcomes.

Firstly, the approaches of the polluter pays principle to light pollution control generally improve awareness of market-based control among manufacturers, businesses and consumers who deal with light pollution. Nevertheless the flexibilities of the polluter pays principle particularly lead to uncertainties of market-based instruments which sets out their limits to control light pollution[330], for example, burden of proof for sky brightness smog at night, the coverage of long-term environmental damage to victims from urban sky glow, and the narrow definitions of significant economic losses due to light pollution.

Secondly, a number of potential approaches of the legislation are able to usefully constitute many financial regulatory incentives to reduce light pollution emissions if they prejudice public safety or harm to the environment. However, existing legal systems or dominant jurisdictions have not specifically made use of market-based instruments, including financial schemes, taxation measures, light pollution control grants and dark-sky revolving fund, to achieve light pollution control outcomes.

Next, in market-based approaches, whenever a polluter is unknown or not acting

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[329] De Sadeleer, N. M., *The Polluter-Pays Principle in EU Law - Bold Case Law and Poor Harmonisation: Pro natura : festskrift til Hans Christian Bugge på 70-årsdagen 2. mars 2012*, , Universitetsforlaget, 2012, pp. 405-419.

[330] Scheiber, H. N., Kwon, M. S. and Gardner, E. A., *Securing the Ocean for the Next Generation*, LOSI Conference Papers, 2012, Seoul, Korea, May 2012, pp 15-16.

responsibly, the regulatory frameworks may assume total or partial control of response activities.[331] This means that both a single suspected polluter and multiple suspected polluters may be liable for tax payments that result from influences outside their control. Therefore, polluters' liability may be reduced due to reasonable environmental conditions even if he has taken no action to minimise light pollution. Likewise, stakeholders will be bound by economic incentive rules about how light pollution reduction should be influenced by market-based instruments if legal measures can activate national governments or their local authorities to formally address necessary activities, systems, schemes and programmes by proposing an appropriate market-based approach, allowing environmental remedy where monitoring of each polluting action is difficult and where several polluters contribute to the outdoor brightness levels and misdirected lighting.

Finally, as specific liability regimes based on the polluter pays principle will not allow financial losses to be recovered, unless there are some certain forms of environmental damage or ecological harm, establishing whether these are the matters can be very important.[332] In the context of light pollution control, this principle would functionally suggest a simplistic linkage between those who have caused the excessiveness or intrusiveness of lights in the first place and the costs of having to reduce or minimise the harmful lights. It seems that the proper approach of this principle is to ask how much a polluter would pay for the environmental remedy of their unnecessary or inappropriate lighting practices. Thus, the interpretation of polluter pays approaches is unclear and there is little consensus of what this principle means in a practical light pollution control context. The environmental remedies available to national or local jurisdictions for light pollution control are sometimes complicated, making it unclear how the best choice should be made between the various market-based instruments and

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[331] Segerson, K., 'Uncertainty and Incentives for Nonpoint Pollution Control', 1988 (15) *Journal of Environmental Economics and Management*, available from http://www.sfu.ca/~wainwrig/Econ400/documents/segerson88-nonpoint-jeem.pdf accessed 18 March 2014.

[332] York Law School, *Research and Support for Developing a UK Strategy for Managing Contaminated Sediments (ME 1104) Task 2: Exploring Liability and the Polluter Pays Principle*, York Law School. 2010, p 30.

polluter pays approaches available.

Therefore, all outdoor light users may be entitled to live in the night environment where risks to their health and safety are properly controlled by the quality criteria of outdoor light products if light industry stakeholders enable the consumer to engage in an economic incentive for the production of outdoor light products, confident in the consumer's light pollution knowledge through sustainable outdoor lighting manual and eco-labelling. While the primary responsibility for outdoor light pollution control is not down to light industry stakeholders (for example, the general public, businesses, industries, commercial retailers, and the public sector), it is possible to identify some specific points raised by the application of the polluter pays principle in the context of economic incentives for light pollution control. This means the regulatory requirements may benefit light industry stakeholders by simplifying, clarifying and modernising requirements and provide greater economic incentive mechanisms that are able to provide incentives for them to invest in eco-labelling in regard to light pollution and environmentally friendly light instruction manual. However, two preliminary problems that legislators and policy makers have to confirm before beginning comparative law research are: (1) which key element of environmental law states that whoever is responsible for damage to the night environment should bear the business costs associated with it, and (2) if the light industry stakeholders do differentiate their environmentally friendly light products from non-environmentally friendly light products produced by competitors in an non-environmentally friendly lighting manner, whether the Government followed regulatory requirements to allow them to gain their industrial benefits.

If manufacturers or distributors of outdoor light products do not become aware of unforeseen light pollution harms after products are placed on the market, they may not notify the relevant authorities and the public, as appropriate, without delay.[333] With respect to the light pollution harms from excessive or obtrusive outdoor lighting for

[333] Department of Economic and Social Affairs, *United Nations guidelines for consumer protection*, United Nations. 2003, para 13. available from http://www.un.org/esa/sustdev/publications/consumption_en.pdf accessed 31 January 2014.

environmental impacts and consumer's well-being caused by non-environmentally friendly lighting products, it could be argued that the Government should make a number of requirements, which are concerned with consumer rights in light sources as 'light pollution-related products'.

5.7 Principle of cooperation

Many forms of light pollution control need to be carried out on the basis of shared approaches, which have emerged in response to findings focusing on inappropriate or unnecessary lighting control in the wrong place at the wrong time. Where it is necessary to take action to enforce light pollution control laws, national governments, environmental governing bodies and local authorities generally need to support stakeholders to deliver messages to manufacturers, businesses, distributors, sellers and professionals, especially households and people, on light pollution control laws, as well as light pollution information. A number of provisions on light pollution laws generally require stakeholders to assess if all sources of lights are at risk from inappropriate or non-environmentally friendly lighting, to address the brightness areas and dark-sky preservation landscapes at risk and to take adequate measures to minimise adverse environmental effects from excessive or obtrusive lighting.

Therefore, various forms of cooperative approaches or coordinated measures to mitigate the risks that outdoor lights dangerously pose to human health, dark-sky heritage and economic activities as well as the environment, in particular, present a useful level of understanding of cooperation, how stakeholders prioritise the stage processes of light pollution control, and the specific potential consequences of complying with state enforced environmental and planning laws, including the standards of professional illuminating engineering conduct and architectural lighting practice.

Light pollution control is generally shaped by urban brightness areas in the context of which environmental zones for outdoor lighting control are divided into planning strategies and development schemes. The legal aspects of light pollution control are to be coordinated with boundary and trans-boundary approaches in the field of outdoor lighting. In the case of a domestic boundary, various steps of participatory interaction

between multidiscipline, states, local authorities and other relevant stakeholders could be highlighted. In the case of trans-boundary, various steps of light pollution control call for integrated cooperation and participatory coordination across institutional and disciplinary boundaries. Consequently, all levels may coordinate their lighting practices in shared urban brightness areas and dark-sky preservation landscapes, including with other relevant areas, and shall in isolation not undertake measures that would increase unnecessary or non-environmentally friendly lighting in all jurisdictions. To achieve boundary coordination and trans-boundary cooperation, many international and national bodies may take into consideration long term plans, including sustainable lighting, as well as climate change, in the step process of light pollution control addressed in international and national environmental strategies.

Furthermore, among different legal systems and various preventive activities, there are common light pollution problems, impacts and harms, in spite of the very different typologies of the potential policy approaches and legal measures available for tackling light pollution as mentioned above. So, light pollution control laws will need to describe the necessary coordination of arrangements. Coordination and cooperation between all stakeholders will significantly allow multiple benefits to light pollution control and the dark-sky environment to be delivered. To limit devastating impacts by increasing coordination and enhancing the ability to cooperate, legislation may be aimed at responsible authorities and other stakeholders with a participatory interest in light pollution problems across international and domestic jurisdictions.

These are reflected on both international and national levels by light pollution control measures such as in international level, Principle 7 of the *Rio Declaration on Environment and Development of 1992* which states that '*States shall cooperate in a spirit of global partnership to conserve, protect and restore the health and integrity of the Earth's ecosystem*.' Additionally, on a European level, the EU cooperation between the countries from an environmental perspective delivers key aspects of the state and trends of the environment with a country, including policy, regulatory frameworks and institutional constraints and challenges which have been clearly stated by Article 189 of

the *Single European Act 1986* (SEA).[334] This European framework generally introduced a cooperation procedure between the EU institutes to achieve on the basis of the existing EU environmental laws and to impose unanimity for the harmonisation of light pollution control.[335] For example, the general aims of the light pollution control or dark-sky preservation schemes is to achieve a sustainable approach for controlling light pollution harms to protect dark-sky heritage, the night environment, and human-beings while encouraging improvement of illuminating engineering technology related ecosystems.[336] However, if clear plans or programmes for strengthening trans-boundary or boundary cooperation aimed at securing sustainable lighting for the shared urban brightness areas or dark-sky landscapes are not definitely provided by the responsible bodies, specific cooperation and coordination to preparedness, precaution and prevention may not be planned and implemented at all levels.

Primary cooperation is important to disseminate and share collected light pollution information and preliminary light pollution assessment results with trans-boundary or boundary stakeholders and their local residents of the urban brightness areas or dark-sky preservation landscapes. On the other hand, establishing a participatory approach without understanding the specific environmental problems from each boundary or trans-boundary will lead to misguided practices and failure to achieve cooperation. So, it is important to identify the cooperation roles and coordination schemes. These following points should be taken into account when making a decision on who to involve, at what stage in the process, and how to involve them in relation to the light pollution problems.

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[334] Europe Aid Co-operation Office, *Environmental Integration Handbook for EC Development Co-operation*, European Commission, 2007, p 113-114.

[335] Malcolm, R., *A Guidebook to Environmental Law*, Sweet & Maxwell, 1994, p 79.

[336] For example, the UNESCO Starlight Declaration 1992 requires astronomical bodies and environment bodies to protect dark-sky heritage and the night environment if urban brightness areas and dark-sky preservation landscapes are at risk from light pollution harms. Similarly, the Declaration in Defence of the Night Sky and the Right to Starlight 2007 (La Palma Declaration) also represents a prime opportunity and a universal obligation for cooperation in safeguarding the quality of life and dark-sky environment. See International Initiative in Defence of the Quality of the Night Sky as Mankind's Scientific, Cultural and Environmental Heritage, *Starlight Reserve Concepts*, available from http://www.starlight2007.net/pdf/Starlight%20Reserve%20Concept%20WD.pdf accessed 21 March 2014.

5.8 Strengthening the key environmental law principles for controlling light pollution

An expectation of this research to each given principle of environmental law as referred above, is that a number of necessary concepts and ideas should be followed by a majority of legislators and policy makers in the appropriate circumstances. They are able to reflect worldwide consensus on key aspects of international, European and national environmentally friendly lighting practice having been accepted by the different legal systems of the world. International, European and national jurisdictions have a wide array of legislative discretion to impose conditions on environmentally friendly lighting practices, providing they meet the environmental law norms, concepts and ideas (as set out in key principles of environmental law). For example, in the case of reducing light pollution that affects coastal sea turtles as mentioned in Chapter 2, no specific norms of customary international environmental law seem to apply, although Principle 21 of the Stockholm Declaration and Principle 2 of the Rio Declaration creates a general duty "*to ensure that activities within their jurisdiction or control do not cause damage to the environment....*"[337] and each norm of environmental law generally creates a general duty for all people, government bodies and all relevant stakeholders to take all reasonable and practicable steps to avoid harm to the nocturnal environment. If they do not apply theoretical concepts to real world circumstances, they will not give rise to the need for the compulsory environmentally friendly lighting practices to perform a number of compulsory roles and legal awareness.

While the concepts of fundamental principles of environmental law can be interpreted in many different ways as mention above, they may be driven by a particular environmentally friendly lighting need without fully considering the wider or future impacts.[338] Therefore, the elements of key environmental law principles may be combined through key broad approaches - philosophical, contextual and normative - to

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[337] Wold, C.,'The Status of Sea Turtles under International Environmental Law and International Environmental Agreements', 2002 (5) *Journal of International Wildlife Law and Policy*, available from http://cmbc.ucsd.edu/content/1/docs/wold.pdf accessed 21 March 2014.

[338] Sustainable Development Commission, *What is sustainable development?*, available from http://www.sd-commission.org.uk/pages/our-role.html accessed 21 March 2014.

produce compulsory international, European and national strategies tailored to a range of necessary legislative conditions for human well-being and the healthy night environment. Alternatively, these fundamental principles may be applied through a range of best lighting practice guidance documents for those involved in delivering light pollution control, generally understood as a non-legally binding soft law under illuminating engineering standards for environmentally friendly lighting practice when soft law is understood and committed to the practice of sustainable lighting governance and to the regulatory frameworks to which it is linked.

Chapter 6: International Light Pollution Law

Chapter 6 explores and examines the international or intergovernmental response to light pollution harms and their relevant environmental risks. This Chapter critically reviews a number of international environmental frameworks and other relevant materials in international light pollution control law, which primarily establishes of international awareness. These are intended to raise legal awareness about the possible international actions that may be taken to reduce and prevent the adverse impacts on human health and the night environment.

The light pollution problems increasingly recognised since the 1970s have been regulated on the international plane in two main forms. First, a set of international soft laws have been developed and used as the basis of a current branch of non-legally binding guidance. Such non-legally binding rules, which include all fundamental norms of sustainable development principle, prevention principle, precaution principle, polluter pays principle and cooperation principle, but differentiated illuminating engineering responsibilities, energy efficiency awareness or sustainable lighting practices, to name but a few, have provided the basis for the adoption of more specific illuminating engineering methods tackling specific light pollution problems. Second, the soft law frameworks are being increasingly mainstreamed within the national and local light pollution legislation.[339] However, key norms and main elements of environmental law have not been paid attention to the supporting components of international environmental law which may be binding on international parties and all relevant stakeholders directly. Implementing appropriate principles of environmental law and necessary international environmental provisions may enhance and enable all international parties to achieve the goals of international or trans-boundary light pollution control in the future. Therefore, application of key principles and concepts of international light pollution law is still in the embryonic phase although they are increasingly being considered for the control of sources and uses of non-environmentally friendly light. This means that international environmental law has not yet accommodated a number of different characterisations of light pollution problems

[339] Bartels, L. and Vinuales, J. E., *International Environmental Law (LL.M.) Syllabus*, available from http://www.law.cam.ac.uk/faculty-resources/courses-and-subjects/llm/papers/international-environmental-law/146 accessed 10 April 2014.

that appear in previous Chapters.

Chapter 6 will evaluate critical questions about how and why international environmental law should apply to international or trans-boundary light pollution problems, and how this material is relevant. This Chapter also looks at many gaps in existing international light pollution control instruments where there has been inadequate light pollution control. These international or trans-boundary challenges[340] presented by many modern complex or difficult light pollution problems have prompted international environmental agencies' legislatures to particularly enact their international environmental frameworks to limit or control the harms to the night environment. Finally, this Chapter describes relevant guidance and assesses how legal measures of light pollution law have been translated into international operational measures.

Chapters 5 and 6 are different. Key principles of environmental law in Chapter 5 have been used to analyse and evaluate the performance of such a modern instrument from an environmental law perspective. These principles, even if they are norms of a general nature which give guidance to legal reform, are not directly applied by the courts and governmental agencies to a particular light pollution case, although their approaches to the control of non-environmentally friendly pollutants ideally start at all international, European and national levels.[341] However, Chapter 6 analyses and assesses several current international frameworks that have been adopted by the international bodies in relation to human health and the night environment at international level. This Chapter differentially provides an introduction to international environmental law, explaining

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[340] Emission of light pollution are rapidly expanding across the country due to urban illuminating engineering and urban architectural lighting developments that have created various adverse effects on nocturnal ecosystems, astronomical observations, energy wastage, and climate change. Many nations critically reviews international or trans-boundary light pollution concerns and relevant international considerations associated with the international or trans-boundary light pollution harms and risks. See International Air Quality Advisory Board International Joint Commission, *Summary Document from the Clean Areas and Prevention of Significant Deterioration Workshop*, Morris J. Work Centre for Dialogue, Vancouver, 23 - 24 February 2004, p 21.

[341] Lang, W.,'UN-Principles and International Environmental Law', 1999 (3) *Max Planck Yearbook of United Nations Law 3*, available from http://www.mpil.de/files/pdf2/mpunyb_lang_3.pdf accessed 10 April 2014.

the different types of instruments (from binding treaties and customary international law to non-binding guidelines and other international soft law.[342]); the major international institutions relevant to environmental pollutants; and the rules governing how countries, institutions and international law all interact.

6.1 Basics of international light pollution law

The need to protect, mitigate and eliminate harmful effects of pollution presents a challenge for international law because it is now widely recognised that many different situations are trans-boundary, regional or global in scope.[343] Although previous or existing international frameworks widely provide some general guidelines on sustainable pollution control, there does not narrowly tend to be a number of specific guidelines on light pollution. It also does not particularly address all of the different numerous challenges for trans-boundary light pollution control. In spite of the various different national or domestic light pollution problems, there are some common problems, purposefulness and approaches. This subheading identifies a number of legal instruments for ensuring participatory approaches and adopting integrated light pollution control approaches. It also provides necessary techniques and procedure on how to prevent the internationally-harmful impacts of trans-boundary light pollution and how to adopt fundamental aspects of environmental law and their legal mechanisms to prevent or mitigate the adverse impact of unnecessary or inappropriate lighting in the international jurisdiction. Therefore, this Chapter specially examines what the main characteristics of international light pollution law are created from multi-disciplinary approaches to prevent, mitigate and eliminate harmful effects of light pollution.

Many existing light pollution frameworks emerge from multidisciplinary fields of lighting. It should also be noted that various perspectives falling under the multidisciplinary approaches of environmental law are currently pursued from a variety of adoptions, compliance regimes, techniques and enforcements. Several disciplinary

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[342] Perrault, A., *Using International Law and Institutions to Protect Children's Environmental Health*, Centre for International Environmental Law, 2005, p 9.

[343] Kiss, A. and Shelton, D., *International Environmental Law*, 3rd edition, Transnational Publisher, 2004, pp 5-6.

fields are commonly linked with critical perspectives in light pollution effects and the rules of lighting as referred to in the previous Chapters.[344]

Firstly, the philosophy of light pollution law is entirely consistent across the relevant astronomical observatory concepts. A number of night environment preservation regulations have been proposed to consolidate practices of astronomical observations. They rely upon various conditions in the night sky and dark-sky environment because a modest amount of light pollution negatively degrades diffuse objects. Even though the observation of sky objects with the naked eyes or telescopes depends upon a wide range of local factors such as what the astronomers are told about unpredictable local weather conditions and local dark-sky environment, the regimes of international or trans-boundary light pollution control welcome views on whether it would be beneficial to make any explicit framework about how intrinsic dark-sky landscapes should be a place where people are committed to keeping those skies dark without some kind of concerns about the adverse effects of light pollution on astronomical observations. In this astronomical perspective, local laws or by-laws for light pollution control (such as U.S. state laws or municipal outdoor lighting ordinances) often ensure that local authorities can carry out a wide range of light pollution control measures, including works and measures that promote astronomical sites in any part of a domestic jurisdiction. Nevertheless, the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the International Astronomical Union (IAU) are two intergovernmental organisations dedicated to the equitable and sustainable management and development of the shared dark-sky or trans-boundary night environment. They introduce the sovereign right on jurisdictions bordering trans-boundary dark-sky landscapes and nocturnal areas to use such shared atmosphere within their jurisdictions in accordance with their own legal frameworks for the environment and impose on them an obligation to ensure that their activities do not cause undue damage to the night environment of other jurisdictions or of areas outside their domestic jurisdictions as explained further below.

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[344] Fitzmaurice, M., *Contemporary Issues in International Environmental Law*, Edward Elgar, 2009, p 207.

Secondly, light pollution law has a wide range of characteristics derived from the need to take into consideration the natural law of lighting basic to light, colour, reflection, refraction, etc. Many approaches to light pollution control require the consideration of both perspectives of illuminating engineering and architectural lighting design. Legislatures, policy makers and light practitioners also need to be aware of lighting practices and relevant light pollution issues, as circumstances may arise in normal or special light uses where adhering to the provisions of international light pollution law is required[345], e.g. international commitment concerning lighting standardisation among the different jurisdictions, appropriate scientific efforts to mitigate light pollution in the urban brightness area or in the dark-sky landscape concerned and forms of scientific responsibility for new light pollution harm. International obligations to control light pollution are able to be formulated in terms of scientific approaches as mentioned in the following paragraphs.

Next, light pollution control in many economic contexts is either economically attractive or affordable for international or intergovernmental decision-makers, particularly in the long-term. Market-based economic instruments are able to encompass a range of economic regulatory instruments from pollution taxes and marketable permits to international market systems and performance bonds through their light pollution reduction targets applied universally across polluters.[346] For example, the combination of ecodesign and energy labelling will be alternatively considered as one of the most effective economic regulatory instruments in the area of energy efficiency. Consumer understanding[347] of the light pollution warning labels and the education campaign on

[345] Pisillo-Mazzeschi, R., 'Forms of International Responsibility for Environmental Harm', in Francioni, F. And Scovazzi, T., (eds), *International Responsibility for Environmental Harm*, Graham & Trotman, 1991, pp 15-36.

[346] United Nations Environment Programme, *The Use of Economic Instruments in Environmental Policy: Opportunities and Challenges*, United Nations Environment Programme, 2004, p 11.

[347] Light pollution generally comes from inappropriate or non-environmentally friendly lighting products, for example, unshielded exterior lights and inefficient outdoor lights. They are internationally manufactured and traded, with very big global similarities as well as very small regional differences. Minimum product performance standards currently exist in almost all major international or regional markets. International collaboration for light product standardisation could particularly focus on aligning test standards and minimum performance standards for light pollution control and developing standards for minimising light pollution impacts in the future. See International Energy Agency, *Transforming*

light pollution-related product choices may internationally help to reduce excessive or obtrusive light energy consumption by changing consumer behaviour.

Finally, many legal aspects of international light pollution law are linked to the fundamental principles of international environmental law as discussed in Chapter 5. They not only directly influence national law, but also on intergovernmental or regional law and through that national or local law. These are supported by many fundamental substantive principles and fundamental procedural principles[348] to exercise their international light pollution control related intergovernmental functions with a view to reducing overall inappropriate and non-environmentally friendly outdoor lights. As there are various direct connections between the principles and rules of the international environmental law, rights, duties and responsibilities[349] from these connections a control could be placed on the impacts of light pollution.[350]

The strengthened relationship between philosophies, light disciplinary approaches,

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Global Markets for Clean Energy Products: Energy Efficient Equipment, Vehicles and Solar Photovoltaics, Organisation for Economic Co-operation and Development and International Energy Agency, 2010 p 14.

[348] Nanda, V. P. And Pring, G., *International Environmental Law and Policy for 21st Century*, 2nd edition, Martunus Nijhoff Publishers, pp 19-70.

[349] For example, a domestic jurisdiction could enter into international regulatory agreements with international or intergovernmental environment organisations, or make a coordinate action to any state undertaking international light pollution control that would otherwise be undertaken by the domestic government. A number of important elements of rights, duties and responsibilities to light pollution control established under the domestic law should be requirements to prepare domestic plans to prevent light pollution. Rights, duties and responsibilities from various direct connections between the principles and rules of the international environmental law should be referred in the domestic environmental law as the common concerns of the probability of light pollution harms and the potential adverse consequences for human health, the night environment, dark-sky heritage and economic activity, i.e. right to light pollution control development, right to a healthful nocturnal environment, right to common dark-sky heritage of human mankind, right to know light pollution harms, duty to do light pollution impact assessment, duty to adopt effective domestic light pollution law (duty to enforce), and state responsibilities.

[350] Where international agreements on the content of step process of light pollution control cannot be reached by the domestic laws involved in delivering domestic environmental and planning measures, the domestic light pollution law could provide for the national environmental agencies or their environmental and planning authorities to intervene and, where deadlocks cannot be broken, to determine the content of the rights, duties and responsibilities for tackling light pollution. See United Nations Environment Programme, *Training Manual on International Environmental Law*, available from http://www.unep.org/environmentalgovernance/Portals/8/documents/training_Manual.pdf accessed 10 April 2014.

economic incentives as well as international environmental law in the field of light pollution prevention particularly represents the narrow set of legal instruments and provisions where many foundations are integrated to varying degrees in different circumstances. Therefore, the subheadings that follow seek to evaluate development, sources, and implementation of the international light pollution law. After this critical discussion, they present how international responsibility or relevant compliance mechanisms are to be ensured by international light pollution frameworks in cases of light pollution control, these are unnecessary lighting control or non-environmentally friendly lighting practices subject to light pollution control, legal challenges that will need to be further addressed by the international light pollution law in the future.

Outdoor lighting products that conform to the relevant safety standards are generally assessed before being placed on the market in England whereby lighting manufacturers try to satisfy the consumer products standard requirements, lighting products are not faulty or defective goods. Light pollution-related products are not all about faulty or defective light equipment, but the light sources may result in the light pollution problems if they are inappropriately used by consumers.[351]

For many light industrial 'light pollution-related products' problems overlap substantially with regulatory requirements, product safety control, even environmental problems. This may lead light manufacturers or businesses to response to the environmental issues of light pollution.[352] This research review is specifically concerned that the English legal system does not balance between consumer rights and responsibility for consumers, light manufacturers as well as light businesses. Non-environmentally friendly practices and inadequacy of the English measures become main problems. English law needs to be clear and simple in order to control light pollution from the all excessive or inappropriate use of light equipment.

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[351] However, a person who is injured by a light product with a defective design can seek consumer redress through product private liability laws in provision of compensation and deterrence in context of the Product Liability Act 1987 and General Product Safety Regulations 2005. See Ramsay, I., *Consumer Law and Policy: Text and Materials on Regulating Consumer Markets*, 3rd edition, Hart Publishing, 2012, pp 609-611.

[352] Abbot, H. and Tyler, M., *Safer by Design: A Guide to the Management and Law of Designing for Product Safety*, 2nd edition, Design Council, 1997, p 107.

Furthermore, the average consumer in England must be told whether a product is environmentally-friendly and energy efficient. Meanwhile, according to the *Ecodesign for Energy-Related Products Regulations 2010 (S.I. 2010/2617),* the English provisions, introduced by the UK government's latest policy instrument to drive take up of energy-efficiency measures, recently improved the environmental performance of energy-related products throughout the life-cycle, by integration of environmentally friendly aspects at a very early stage in energy product design.[353] Nevertheless, when consumers use their light products, guidance is not provided on environmentally friendly use of light.

There may be difficulty in recognising all the consumer information of light pollution because English laws on energy-related product control do not provide the appropriate balance between protecting consumer health and well-being from light pollution and ensuring the profits of the lighting industry. While these *Ecodesign for Energy-Related Products* provisions benefit both businesses and consumers, by enhancing product quality and environmental protection across the EU[354], light manufacturers and businesses who have not been specifically required to meet the obligation will be the people who have to comply with the disclosure of light pollution information and risk factors. Accordingly, English laws might tend to provide a duty for disclosure and acknowledgement of 'light pollution-related products' information. To maximise the level of light pollution control, there should be truthfulness on the risks of light pollution impacts, therefore supporting light consumers to make better-informed choices when they consume 'light pollution-related products'.[355]

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[353] Department for Business, Innovation & Skills, *Environmental regulations Involved in the development, domestic implementation and enforcement of certain European waste and environmental legislation*, available from https://www.gov.uk/environmental-regulations accessed 31 January 2014.

[354] The Ecodesign for Energy-Related Products Regulations 2010 (S.I. 2010/2617) is laid down in implementing measures to the Directive 2009/125/EC of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products. It adopted two ways of reducing the energy consumed by lighting products: the labelling to raise the awareness of light consumers and the energy efficiency requirements imposed to light products on the light design step. See European Commission, *Energy Efficiency: Eco-design of Energy-Related Products*, available from http://ec.europa.eu/energy/efficiency/ecodesign/eco_design_en.htm accessed 2 February 2014.

[355] Oughton, D. and Lowry, J., *Consumer Law*, 2nd edition, Oxford University Press, 2000, p 492. and See

If the lighting industry has obligations give environmental instruction about light pollution impacts connected with 'light pollution-related products' that may be useful for consumers, the English ecodesign labelling might accompany warnings with light pollution risks and instructions concerning the 'light pollution-related products'. Notwithstanding, light manufacturers and businesses have no legal responsibilities with regard to warning light consumers about risk factors associated with the use of 'light pollution-related products'.

In order to increase light pollution knowledge of consumers' means, they should be focusing on how best to provide people with light pollution information, which builds redress into the economic markets. Technically, aspects of environmental law and market based instruments may ensure that all consumption activities of light products are safe for the environment, for example, various labelling requirements may encourage light manufacturers and businesses to consider the potential environmental damages of their trading decisions as proposed in the Chapter 8 and 9. [356]

6.2 Evolution of international light pollution law

The history of light pollution control involves stories of legal responses to dark-sky heritage preservation that generally require international light pollution responses. They began against the background of the efforts in tackling light pollution began in the 1970s, which emphasised the right to observe the stars as a common heritage of humankind and the right to live in a healthy night environment. Light pollution problems led to both the responses of global and domestic dark-sky organisations with different jurisdictions over specific astronomical and environmental problems affecting humankind a broad array of rights of actions where light pollution has an effect on astronomical observations, ecological systems, energy wastage and other relevant harms.

During the twentieth century, dark-sky protection has become increasingly necessary as

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Abbot, H., *Safe enough to sell?: Design and product liability*, Design Council, 1980, p 63.

[356] Turner, R. K., *Environmental Policy: An Economic Approach to the Polluter Pays Principle CSERGE Working Paper PA 92-04*, Economics Association One World Annual Conference, Liverpool, 22-24 April 1992, p 4.

the number of outdoor lights available has grown dramatically. So, international light pollution law provides the basic norms by which international or intergovernmental organisations cooperate over non-astronomically friendly or non-environmentally friendly lighting matters. More specific international frameworks related to dark-sky preservation and nocturnal environment protection can be found in a limited number of dark-sky declarations. Within the international context, examples include the recently adopted international light pollution frameworks and the model laws of the professional organisations for lighting designers and practitioners. On the other hand, much more effort is needed to study lessons from current international light pollution frameworks to enhance a comparison of international environmental laws in the field of light pollution laws for responding to environmental problems in international or trans-boundary light pollution.

The United Nations Conference on the Human Environment (Stockholm Declaration), which was adopted by Member States at the *1972 United Nations Conference on the Human Environment*, was the first international declaration to make reference to international approaches to a common outlook and common principles for setting out key principles to inspire and guide international or intergovernmental environmental organisations in the preservation and enhancement of the human environment. In particular, it provides a useful tool to enable Member States' decision-makers or legislators to set standard terms in environmental protection, including international consensus on pollution problems as well as comprehensive measures to address many broad categories of applications setting out how pollution control will be achieved by international legal responses.

The Stockholm Declaration takes various key approaches, and sets environmental benchmarks for international pollution control. It marks legal measures to support the ecological balance of human health and the environment. It also goes beyond the previous approach of dealing with pollution control. Many basic principles of international environmental law have been conceptualised within the aspects of the Stockholm Declaration, for example, basic international instruments for the protection of the environment, legal measures to mitigate the adverse consequences of new

environmental harms and rights to healthy environment in the Member States' constitutions. From aspects of the Stockholm Declaration, the international provisions of light pollution from inappropriate or unnecessary lights are developed among those dealing with non-astronomically friendly or non-environmentally friendly light pollutants. It generally contains common principles to inspire and guide the international environmental bodies in the preservation and enhancement of the human environment. Nevertheless the generality of some provisions and their uncertain terms[357] should no longer bring both international and domestic jurisdictions into narrow approaches to light pollution control. They need to be cooperatively formulated in the specific form of declarations of rights and duties of states to attend to light pollution control through common means with generally agreed guidelines.

Over thirty years ago, many international dark-sky bodies, concerned about the adverse impacts and their consequences of the degradation of dark-sky quality and the nocturnal environment, decided to formally convene an international conference on the dark-sky heritage. The Declaration in Defence of the Night Sky and the Right to Starlight or the La Palma Declaration, which came into effect on Monday 20th April 2007, takes forward a number of astronomical and environmental recommendations from the international dark-sky bodies into the light pollution impacts and introduces a number of responsibilities on the international dark-sky bodies and authorities to control the harm of light pollution. Whilst it is not strongly legally binding[358], many terms of this international framework are officially selected to identify that the parties and relevant stakeholders intend to make legal commitments and purpose aspirations for greater astronomical dark-sky and environmentally friendly approaches in different

[357] Sohn, L. B., 'The Stockholm Declaration on the Human Environment', *Harvard International Law Journal*, 1973 14 (3), pp 423-515.

[358] Likewise, declarations are not always legally binding because compulsory dark-sky preservation is not often demanded by civil or common law jurisdictions. So, some jurisdiction abandons international commitments to dark-sky heritage protection and night environment sustainability through measure and other legal enforcement.
It is often deliberately chosen to show that the relevant parties do not intend to establish international law obligations but merely need to declare certain purposive aspirations or common targets. See United Nation, *Definition of key terms used in the UN Treaty Collection*, available from https://treaties.un.org/pages/Overview.aspx?path=overview/definition/page1_en.xml accessed 15 April 2014.

jurisdictions. In spite of this diversity of international law terms, however, a variety of international laws to define international environmental measures has been developed by many practical approaches. The main terminology of the international environmental laws employed in the basics of international law to refer to international environmental instruments binding at international law[359]: treaties, agreements, conventions, charters, protocols, declarations, memoranda of understanding, modus vivendi and exchange of notes. Even though there is, recognition by the international community of the importance of light pollution control, international or intergovernmental frameworks have not made possible the conclusion of number of various international environmental instruments on the international or trans-boundary light pollution control. In addition, other existing international environmental frameworks may not specifically address light pollution problems, but merely help provide support frameworks for other relevant effects of light pollution on human health, ecological diversity and the night environment.

6.3 Sources of international light pollution law

Despite proliferation of the light pollution problems at international level, there are still a number of international environmental laws without adequate legal provisions for cooperation of sustainable lighting practice. The inadequacy of the will to develop and implement the international frameworks needed to internationally coordinate light practices within the various international bodies and to control outdoor lights in an integrated control adds to the light pollution problem. While there is no specific international solution, the following pillars of the current international environmental laws are indirectly considered as necessary for some areas of light pollution control.

International organisations have not officially established a hierarchy of sources of international environmental law in specifically resolution of trans-boundary light pollution disputes and tackling international light pollution problems. However, if neither a light pollution provision nor a customary light pollution rule of international environmental law can be identified, alternatively reliance may be placed on the general

[359] United Nations Treaty Collection, *Treaty Reference Guide*, 1999, available from http://untreaty.un.org/English/guide.asp. accessed 15 April 2014.

principles of environmental law recognised by civilised nations.[360] They themselves could fill the gaps in incompleteness of international environmental frameworks and the lack of specific light pollution provisions. As an alternative, environmental norms of light pollution control may be derived from the traditional sources of international environmental laws, for example, international conventions, customary international laws, general principles, judicial decisions and other relevant sources of obligations. Therefore, to identify existing gaps in the current framework of international environmental law and to determine where additions to the international environmental framework are required, once the gaps would be filled, and the general principles of international environmental law are developed further in an international context, a more comprehensive international light pollution control framework or international codification could be considered. This part analytically examines how light pollution is controlled by the international environmental law and where international or intergovernmental bodies can go to find out more details to introduce a simplified scheme for future light pollution reform's international agenda.

As mentioned in the previous chapter, adverse light pollution effects, as referred to in Chapter 2, can be highlighted that light pollution needs to be considered at the same time as international and trans-boundary legal dimensions. Although the international jurisdiction has not adopted totally consistent approaches on all light pollution issues, filling the gaps by using separate instruments, while preserving coherence between the individual instruments should strongly be considered to make decisions on light pollution effects.

Firstly, light pollution has an adverse impact on global or trans-boundary ecology and biodiversity. It has been underpinned to clearer ecological preservation and remedies to improve biodiversity protection when a domestic jurisdiction fails to meet reasonable ecologically friendly lighting standards. Many international environmental frameworks applying the ecological light pollution control provide a high level of ecological and

[360] See Article 38 of the Statute of the International Court of Justice in International Court of Justice, *Statute of the International Court of Justice*, available from http://www.icj-cij.org/documents/index.php?p1=4&p2=2&p3=0& accessed 15 April 2014.

biodiversity protection, but certainly not in all situations, for example, the Convention on Wetlands of International Importance, Especially as *Waterfowl Habitat 1971*, the *Convention on the Conservation of Migratory Species of Wild Animals 1979*, and the *Convention on the Conservation of Biological Diversity 1992*.

Secondly, whilst light pollution may result in adverse effects on the night environment and dark sky heritage, the Declaration in Defence of the Night Sky and the Right to Starlight or the *La Palma Declaration 2007* established a non-legally binding obligation to reduce light pollution. However, this international dark-sky framework is difficult to understand because an astronomer's rights differ according to the type of each jurisdiction's night environment (for example, dark-sky geography, astronomical demographics, lighting culture) and because some astronomical rights leave plenty of scope for dark-sky preservation, (for example, the relative degree of lightness or darkness demonstrated by a given real neutral dark-sky standardisation).

Thirdly, increased use of outdoor lights has resulted in global warming potential. The energy supply sector generally creates a number of different outdoor lights, including security lights, floodlights, street lights, and advertising and display lights. People consume light derived from the electricity of the light energy producing greenhouse gases. So, greenhouse gas, traps heat from the sun, has contributed to an increase in the world and country temperature.[361] Even though the need to reduce greenhouse gas emissions (GGEs) under the *United Nations Framework Convention on Climate Change 1992* and the *Kyoto Protocol 1997* would appear to consider what international or intergovernmental bodies could do to limit average global temperature increases and the resulting climate change, and to justify restrictive caps on energy used to reduce GGEs from inappropriate or unnecessary outdoor lights in international jurisdiction,[362] it would seem that various types of relationship between light pollution and global warming have not been specifically considered by a couple of international global

[361] Department of Energy & Climate Change and National Statistics, *2013 UK Greenhouse Gas Emissions, Provisional Figures and 2012 UK Greenhouse Gas Emissions, Final Figures by Fuel Type and End-User*, National Archives, 2014, p 15.

[362] Clark, B. A. J., *A Rationale for the Mandatory Limitation of Outdoor Lighting*, Astronomical Society of Victoria Inc, 2008, p 79.

warming frameworks.

Fourthly, light pollution from the workplace, transportation and community is a major environmental risk to safety. Many international safety frameworks which introduce various significant areas of safety regulation in many parts of the world called for a concerted attack on all risks to national occupational safety and health policy, for example, the *Promotional Framework for Occupational Safety and Health Convention 2006*, the *Vienna Convention on Road Traffic 1968*, the *International Convention for the Safety of Life at Sea 1974*, and the *Chicago Convention on International Civil Aviation 1944*. Many jurisdictions use them to include requirements for safety reasons where outdoor objects could be seen and recognised if the appropriate or necessary illumination were raised to a daylight level at night, but these frameworks do not aim at the establishment of a mechanism for seeking a balance between safety and light pollution control. Much of the debate about the regulatory reform agenda, both internationally and nationally, has been about balance: the cost of light pollution controls on the one hand, versus the cost that regulation to eliminate safety hazards on the other, as mentioned in the conclusions.

Next, there is international recognition of the links between people's rights and lighting. It would seem then that the correlation between the right to healthy, safety and ecologically-balanced environment and the right to artificial light would be found to exist to the degree that various purposes of light uses affect international climate change and the global environment as previously discussed. International laws relating to the rights to artificial light, and for purposes connected therewith have drawn attention to the relationship between a safe and healthy environment and the enjoyment of human rights, for example, the *United Nations Framework Convention on Climate Change (UNFCCC) 1992* which constitutes light pollution awareness through the designation of sustainable energy efficiency standards in manufactured products and components for manufactured products and the *Energy Charter Treaty (ECT) 1994* which recognises the necessity for the most efficient production and consumption. However, there would be a lack of specific international authority on how the principles of international environmental laws were to be applied in international or trans-boundary light pollution

control.

Finally, lighting designers and practitioners have been concerned that including excessive brightness and poor alignment of some outdoor lights practices would be too wide and uncertain in international scope. Although a general duty of light pollution control is necessary to internationally define in lighting architecture and illuminating engineering terms, many international lighting governing bodies have not properly expressed concern about the potentially international scope of a general duty to control light pollution and to practice ecologically-balanced lighting that an average lighting practitioner may especially need to know to make a decision on the approach to dealing with light pollution problems. For example, the International Association of Lighting Designers' Code of Ethics and Professional Conduct (IALD's Code of Ethics) and the International Commission on Illumination Standards (ICI's Standards) have not been adopted to promote and maintain the maximum light pollution control.[363]

6.4 Customary international light pollution law

The boundaries of the upper atmosphere are shared by more than one nation. They are generally controlled by countries above their territories, including its geographic boundaries of legal jurisdictions, territorial brightness areas, natural dark-sky landscapes or, more generally, any specific lighting portions of the atmosphere. The need to cooperate on the shared dark-sky or brightness landscapes at the trans-boundary level will support effective mechanisms of joint brightness areas or dark-sky landscapes for trans-boundary light pollution control where a limit brightness or dark-sky territory borders more than one state. Challenges to international light pollution control cooperation include the lack of international light pollution frameworks, differing protective measures at individual level, differing understanding of where and when international or trans-boundary light pollution impacts could happen and how serious they might be, and the lack of international or trans-boundary duty to make plans to

[363] Simplification and clarification of the professional code of conduct for light pollution control practices would be an important and necessary contribution to international light pollution control generally, but there is no set of general rules of lighting conduct, and almost nothing is to be gleaned from the professional practice frameworks.

assess, precaution, prevent, and mitigate the effects of light pollution.

From a trans-boundary perspective, it is important to increase international environmental law awareness of the fact that nations share the same atmospheric lighting landscapes because of the growth of human populations and changing patterns of outdoor light use by those populations. [364] Disagreement over the light pollution control of shared atmospheric brightness or dark-sky areas between two or more states not only leads to human health problems, loss of the night environment and other relevant damage, but also lead to territorial disputes. These disputes are perhaps related to the possession of dark-sky heritage, ecological systems, and human well-beings where trans-boundary glare, glow and light intrusiveness could occur in all shared brightness areas. Although trans-boundary disputes may also be driven by increased use of lighting in the wrong place at the wrong time, establishing a customary international environmental mechanism to control trans-boundary light pollution could support trans-boundary dark-sky or brightness landscapes.

This part critically analyses the possible development of customary international law as a vehicle for addressing the international or trans-boundary light pollution problems of the need for cooperative management of internationally shared brightness areas or dark-sky landscapes, involving a discussion of the contexts of future customary international light pollution law specifically.

The border disputes from outdoor light allowed to illuminate, or pollute, areas not intended to be lit may occur in situations where intrusiveness of the lights sometimes shines through the territory of another state or the boundary of another nation. The impacts of light intrusiveness can have an impact on dark-sky landscapes, human well-being and wildlife of a borderland. For example, trans-boundary light pollution problems can be interpreted in terms of the imbalance outdoor light uses resulting from urban spatial expansion in borderlands, as well as from sky glow illumination between shared boundary areas or two countries' joint light premises. Building on the international or trans-boundary light pollution frameworks involves understanding all

[364] European Commission, *Green Public Procurement: Street Lighting and Traffic Signals Technical Background Report*, European Commission, 2010, p 3.

mechanisms behind light pollution risk in a borderland, and how light pollution harm may change in the future as a result of international environmental conflicts are integrated and balance trans-boundary light pollution control. However, there is no attention paid to trans-boundary light pollution issues and trans-boundary conflicts of territorial light pollution disputes in particular, whilst this research seeks to address various environmental matters in the border region resulting from the rise of many pollution problems.

Since the invention of the outdoor lighting technology strong enough to light up exterior areas, artificial lights at night have become an important necessity of human life and some national jurisdictions have required public bodies and statutory organisations to reduce the impacts of light pollution, but legal approaches based on customary international light pollution law or official norms in the regulation of trans-boundary light pollution have failed to address the environmental problem in a sustained fashion, and as a consequence no specific legal norms have been generated.[365] International environmental bodies may develop detailed customary laws or substantive rules to address particular light pollution problems through adapting customary international environmental law to the needs of the international or trans-boundary light pollution control when one state undertakes unnecessary or non-environmentally friendly lighting practices that affect other states.

So, international environmental lawyers look to increase their understanding of where and when international or trans-boundary light pollution could happen and how serious it might be.[366] They may present customary light pollution control norms in greater detail if there are many cases international or trans-boundary disputes resulting from unclear provisions in an international environmental framework that set up the original boundary. While customary light pollution rules may include the fundamental

[365] Merrill, T. W., 'Golden Rules for Tran-boundary Pollution', *Duke Law Journal*, 1997 5 (46), pp 931-1019.

[366] Customary international light pollution law could be considered as an important source of international environmental law when we have witnessed a proliferation of inappropriate or non-environmentally friendly lights. See Bodansky, D., 'Customary (And Not So Customary) International Environmental Law', *Indiana Journal of Global Legal Studies*, 1995 1(3), pp 105-119.

principles of light pollution law as mentioned in Chapter 5[367] but differentiated responsibility, rules would involve the international obligation to control trans-boundary light pollution and the rules relating to responsibility and liability for such trans-boundary light pollution, the obligation to cooperate and the requirement for dark-sky quality measures or nocturnal impact assessment for brightness areas and dark-sky landscapes having trans-boundary effects.[368]

Even though the dark-sky preservation rules have just been legalised in international law in this century, dark-sky heritage and natural night has a long history in many parts of the world, dating back centuries. New international customary light pollution should be considered in relation to the existing international environmental frameworks, as well as the other relevant contexts in which they will be implemented.

In the future, customary international light pollution rules may be derived from cooperation[369] with neighbouring countries and regions or conflict[370] between uses of shared brightness areas. They will continue to play a significant role in the settlement of trans-boundary light pollution disputes concerning shared brightness areas or joint dark-sky landscapes where international frameworks cannot be entered into by means of an international treaty or an international agreement. They may involve a particularly significant contribution to the development of international environmental law where the use of soft law declaratory instruments has been so widespread. The last Chapter investigates the extent to which future customary international light pollution rules will be applied to international light pollution law on shared brightness areas or joint dark-

[367] However, some legal scholars have argued that some principles do not form commonly applicable customary international law, for example, market-based instruments for light pollution control. See Scheiber, H. N. and Kwon, M. S., *The Liability and Compensation Mechanism under International Marine Environmental Law Adopting the Polluter Pays Principle to Control Marine Pollution under International Law from the Aspect of International Cooperation*, LOSI-KIOST Conference on Securing the Ocean for the Next Generation, Seoul, 21-24 May 2012, p 14.

[368] McIntyre, O., 'The Role of Customary Rules and Principles in the Environmental Protection of Shared International Freshwater Resources' *Natural Resources Journal*, 2006 5 (46), pp 157-210.

[369] Burleson, E.,' A Climate of Extremes: Transboundary Conflict Resolution' *Vermont Law Journal*, 2008 32 (477), pp 477-523.

[370] Drifte, R., *ARC Working Paper 12: Transboundary pollution as an issue in Northeast Asian regional politics*, available from http://eprints.lse.ac.uk/25201/1/ARCWP12ReinhardDRIFTE2003.pdf accessed 29 April 2014.

sky landscapes, in particular, and whether and how development of the customary international light pollution rules are incorporated into international law instruments.

6.5 Implementing international light pollution law

The critical question here is whether international environmental law can be globally used to solve light pollution problems that the international dark-sky frameworks or other relevant international environmental frameworks also can be internationally used to solve global and trans-boundary light pollution issues while inappropriate or unnecessary lights globally have spread due to excessive, misdirected, or obtrusive lighting at night.

Dramatically increasing impacts of light pollution has provoked a maelstrom of questions about international environmental law. Despite some international dark-sky bodies and intergovernmental environmental agencies suggesting that it is reasonable to presume that acceptance of principles, customary laws and international frameworks behind international environmental law regimes become the fundamental importance of dark-sky and the night environment protection for the development of international and domestic light pollution regimes as a whole, implementation of the international environmental law may not be delivered by suitable law means, which needs to be created or defined by international level implementing measures or domestically at the national level.[371] While the *Declaration in Defence of the Night Sky and the Right to Starlight (La Palma Declaration 2007)* 's light pollution control standards reflect international environmental law concerns[372], domestic legal systems' adoption or

[371] As explained in the detail of international regulatory frameworks, international dark-sky bodies and intergovernmental environmental agencies have played a positive role by recognising the light pollution problem of excessive or obtrusive lighting related dark-sky and the night environment issues. They set out many key vehicles to achieve goals of the global or trans-boundary light pollution control to improve the light uses of people by raising their awareness of international light pollution issues from ecologically-balanced lighting or non-environmentally friendly lighting and to improve the night environment quality of the conservative dark-sky landscape and urban brightness areas on offer by adopting or implementing with domestic jurisdictions. Increasing the awareness within international environmental law regulators, environmental policy-maker and dark-sky campaigners on how international law applies and implements in domestic legal systems.

[372] Within the contexts of light pollution globalisation, a distinct challenge identifies how international or trans-boundary light pollution impact affects calls for the adoption of international measures envisioned

integration of the La Palma Declaration's standards is unknown whenever there is no statutory requirement related to international law in many jurisdictions.

International environmental law can be established in three main ways[373]: (1) by formal agreement between countries, (2) in the form of customary rules, and (3) by derivation of general environmental law principles common to major legal systems. Nonetheless, the *La Palma Declaration 2007* as a non-legal binding framework sets a global resolution of light pollution control and it does not formally create international or trans-boundary obligations enforceable in national jurisdictions or domestic legal systems. Again, states have never agreed to recognise the privileges and obligations in domestic light pollution situations because national parties to the Declaration are not formally obligated to develop and endeavour to put into practice their domestic standards setting out how they will officially implement various aspects of the Declaration.

Whilst they had no obligation to adopt regulatory approaches designed to limit light pollution from global or trans-boundary light pollution, several states and European jurisdiction themselves officially set out detailed rules that seek to limit the effects of excessive, obtrusive and unnecessary lighting. Regional or domestic restrictions and relevant measures have also been taken at regional and domestic levels to deal with light pollution.

As explained above, this is not a *cul-de-sac* of refusing to deliver international standardisation of light pollution control, but an international light pollution framework will be officially introduced as soon as practicable on the single international law when dark-sky governing bodies and international environmental agencies decide to commonly create a new international light pollution law in the future, if trans-boundary cooperation or shared conflicts are dramatically raised by their member parties. As this research employs the methodology of comparative law in this research, it addresses both

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by international light pollution frameworks, such as frameworks for promoting dark-sky heritage preservations, including globalised stage processes for applying international light pollution law standards and investigating sustainable lighting methods.

[373] Garcia, M. J., *International Law and Agreements: Their Effect upon U.S. Law*, Congressional Research Service, 2014, p 1.

the needs to recognise adequate light pollution control to meet the existing requirements of international environmental standards and to reform new specific light pollution through analysis and discussion of the similarities and differences of international light pollution law.

The basic understanding of international light pollution developments may come from comparative international hard and soft law studies because from a comparison between all hard and soft law norms can emerge or techniques of international light pollution law designed to preserve and protect the dark-sky or environmental values.[374] Even though hard law arises from international pieces of legislation in international law contexts, soft law may be subjected to influence on legal aspects of both international and domestic hard law.[375] It can play a significant role in the introduction to a broader theoretical understanding of light pollution control norms, for example, the legislature can gain various aspects of light pollution control from the La Palma Declaration's non-legally binding standards and it gives an awareness of light pollution concerns through analysis and discussion of the origins and various characteristics of different light pollution impacts. Therefore, national jurisdictions, where their legal systems consist of various differences, similarities, and interrelationships will be able to create international lighting cooperation or manage international or trans-boundary lighting conflicts after they adopt the specific approach to the implementation of international hard or soft law in their domestic legal system and proclaim international hard or soft law to be part of domestic law.[376]

So, the last subheading of this Chapter will examine a comparison between similarities and differences of the key materials of international light pollution laws. Comparative international light pollution law will critically discuss the increasing importance of the

[374] Eberle, E. J., 'The Method and Role of Comparative Law', *Washington University Global Studies Law Review*, 2009 3 (8), pp 451-486.

[375] Trubek, D. M., Cottrell, P., and Nance, M., *"Soft Law," "Hard Law," and European Integration: Toward a Theory of Hybridity*, University of Wisconsin-Madison, 2005, pp 1-42.

[376] However, adopting all appropriate legislative light pollution measures for the implementation of the international light pollution control recognised in the existing international frameworks has not always been transformed into reality because there is no a specific international light pollution framework as a hard law which is more conducive to the realisation of the duties of nations with light pollution control and which may be contained in the national or local provisions of domestic legal systems.

development and enforcement of international light pollution law in the future.

6.6 Responsibility for international and trans-boundary light pollution in international law

To encourage maximum cooperation standards of international pollution responsibility for those engaged in the environment protection to domestic legal systems, international environmental authorities generally develop or maintain pollution policy, taking into account the pollution guidelines set out above and relevant international agreements. [377] International cooperation[378] will close both international and domestic regulatory loopholes and will thus cooperate to a more effective establishing of the international pollution control regime.[379] International pollution frameworks will be legally binding and directly applicable in which they set responsibility for promoting sustainable pollution protection through international compliance mechanisms. This subheading critically analyses some questions that are relevant for assessing whether a State must meet its international responsibilities even where light pollution continues to increase for many years.

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[377] However, the emergence of a number of closely integrated sets of rules of international law pertaining to particular subject-areas such as, the environment, sustainability, and international energy has sometimes led to conflicts between such specialised sets of rules and the general law as well as between different sets of specialised rules. For example, various dark-sky governing bodies currently lead to a peaceful way of cooperation in safeguarding the quality of dark-sky. On the other hand, dark-sky conflicts may be a term describing a conflict between jurisdictions, nations, or states over enjoyment of shared dark-sky atmosphere or joint nocturnal environment. The shared adverse dark-sky changes taking place in the trans-boundary areas are transforming both the security conflict and environment conflict because international or trans-boundary laws do not ensure so far as is reasonably practicable the health, safety and the environment at shared dark-sky landscapes or joint brightness areas of all trans-boundary citizens in the future. See International Law Commission, *Fragmentation of international law: The function and scope of the lex specialis rule and the question of 'self-contained regimes'*, available from http://legal.un.org/ilc/sessions/55/fragmentation_outline.pdf accessed 29 April 2014.

[378] Although it is not necessary to prove for every single rule of international environmental law that every state consented to it, domestic legal systems generally encourage environmental cooperation in the implementation of international pollution prevention policies to achieve greater results within their existing pollution problems or their trans-boundary pollution conflicts. See Oppenheim, R. L., *International Law: A Treatise*, Lawbook Exchange, 1920, p 17.

[379] In favour of a single international law for all kinds of international or trans-boundary light pollution problems, intergovernmental bodies may revive the calls for a single regulatory framework by illustrating the failure of the previous or current regimes to deal with all aspects of light pollution that contain both international and trans-boundary elements, specifically international light pollution problem.

Several States have the responsibility to ensure that outdoor lighting activities within their jurisdiction or control do not cause damage to their States' environment or other States' environment under current international legislation. It has been created in the common conviction when many States have, in accordance with the international environmental regulatory frameworks and the principles of international environmental law, the sovereign right to exploit their own resources pursuant to their own environmental policies, and the responsibility to ensure that outdoor lighting activities within their jurisdiction or outdoor light emitted from premises do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction.

Under current hard and soft laws, it provides a non-specific approach to tackling pollution and a number of international laws to help protect the environment introduce various basic elements for responsible involvement.[380] Therefore, by gaining awareness of international or trans-boundary light pollution laws, and how domestic legal systems have the potential to affect the night environment, they will take a more responsible approach to managing risk in their jurisdictions. For example, domestic legal systems are able to incorporate the requirements of the non-specific approach or the general elements of international environmental law into their local or national law where there is no specific law about when light pollution becomes a major international environmental problem for civilisation.

In the near future, this research hopes that international environmental agencies will provide possible light pollution control strategies and encourage international environmental commitments in regard to sustainable light pollution prevention. They could reaffirm their commitments to ensuring the achievement of sustainable light pollution control in all countries and to making it the responsibility of decision-making processes. General obligations for countries regarding pollution prevention and trans-boundary environmental cooperation will lead to legally binding commitments which require State's jurisdictions or domestic legal systems to approach light pollution

[380] Many States have not committed to address international or trans-boundary light pollution problem as a specific environmental problem although some States have successfully adopted legislation designed to limit domestic light pollution from keys elements of inappropriate or non-environmentally friendly outdoor lights.

control in harmonised stage processes.

6.7 International compliance mechanisms and light pollution prevention

While most countries currently rely on their domestic light pollution frameworks to prevent light pollution through compliance with domestic environmental rules, international environmental agencies generally do not provide specific frameworks when light pollution is able to arise from a wide range of lighting activities which are carried out in one jurisdiction, but inflict negative impacts in another jurisdiction.[381] For example, sky glow from one national jurisdiction can interfere with the view of another national jurisdiction's night sky, if they have joint border region as well as shared atmospheric space.[382]

Where any form of artificial light from outdoor light premises shines outside the area it needs to illuminate, the mismanagement of urban brightness areas or dark-sky heritage landscapes is contributing to new trans-boundary environmental conflicts and making serious obstacles to improved environmental cooperation.[383] Non-environmentally friendly outdoor lights (i.e. street lights and security lights) are sometimes operated by two nations when some street light lines generally run through the region. Trans-boundary outdoor lights are compulsorily served by each local lighting governing body which connects the cross-country energy-related facilities and cross-boundary lighting-related premises together. Therefore, conflict prevention strategies of international or trans-boundary light pollution could be designed by international or trans-boundary constituencies in the borders or across jurisdictions. The discussion for and against each of the current situation of global light pollution prevention for compliance approaches is analysed below, focusing on the following areas of the future regimes of international light pollution control and compliance mechanisms through consideration of

[381] Hanqin, X., *Transboundary Damage in International Law*, Cambridge University Press, 2003, p 3.

[382] Trans-boundary atmospheric smog occurs from both border region jurisdictions where the industrialisation and rapid population growth led to adversities including negative impacts on light pollution. See Pick, J. B., Viswanathan, N. and Hettrick, J., 'The U.S.-Mexican borderlands region: a binational spatial analysis', *The Social Science Journal*, 2001 (38), 567–595.

[383] United Nations Interagency Framework Team for Preventive Action, *Toolkit and Guidance for Preventing and Managing Land and Natural Resources Conflicts*, UN Environment Programme & United Nations Interagency Framework Team for Preventive Action, 2012, p 91.

international environmental law.

The regimes of international light pollution control do not currently exist in the international legal systems.[384] They may be insufficient to allow for an international designated body to make a legal action within the current regulatory approaches of international environmental law. They have not yet taken necessary steps to rectify this by establishing an international duty to co-operate with other relevant nations in the exercise of their international or trans-boundary harmonised light pollution control functions.

One key issue for discussion is whether, and how, international harmonised actions should play a part in an enhanced light pollution control system. National legal systems face particular difficulties in bringing any international or trans-boundary harmonised light pollution control, even though some nations, including civil legal systems, and many common law systems have recently adopted legislation designed to limit light pollution from inappropriate and non-environmentally friendly lights. When trans-boundary light spillage or intrusiveness crosses regional borders, as mentioned above, states need to cooperate to resolve environmental problems and share any commitments for improving the way in which outdoor light premises and other relevant public facilities are to be constructed, designed, and maintained and which bilateral or multilateral light pollution agreements must comply. The following two recent approaches illustrate the future sustainable cooperation that the compliance mechanisms of bilateral environmental agreements (BEAs) and multilateral environmental agreements (MEAs)[385] may need to consider in cases of international or trans-boundary light pollution risk management when environmental issues from unnecessary or inappropriate lights have implications beyond national boundaries, or involve issues of global concern.

A more specific agreement approach to international or trans-boundary light pollution

[384] Kerry Dark Sky Reserve, *Application to the International Dark-Sky Association for consideration of a Dark-Sky Reserve in South West Kerry, Ireland*, Kerry Dark Sky Reserve, 2013, p 26.

[385] United Nations Environmental Programme, *Guide for Negotiators of Multilateral Environmental Agreements*, Foundation for International Environmental Law and Development & United Nations Environmental Programme, 2014, p 10.

control is being adopted at BEAs or MEAs levels by domestic jurisdictions. The increase in significant knowledge about the joint environmental problems (i.e. population growth in border areas will lead to increased outdoor light use at night) and the efficient efforts of the BEAs or MEAs' governments to solve trans-boundary light pollution problems will integrate a range of bilateral or multilateral requirements using shared lighting practices and involving joint lighting standardisation, and operating with cross-border areas. If BEAs or MEAs' jurisdictions jointly address these international or trans-boundary problems, they may lead to the adoption of light control legislation employing various techniques of light pollution control which sufficiently set up trans-boundary or cross-border programme of work in the polluted area designed to develop environmental law techniques when applied in BEAs or MEAs levels.

Many jurisdictions, where light pollution becomes a trans-boundary effect of the environment, may need to develop their own strategy for implementing compliance step processes of their bilateral light pollution agreements (BLPAs) and multilateral light pollution agreements (MLPAs). For example, to address these challenges in light pollution in urban border regions, the BLPAs or MLPAs requires nations to approach dark-sky quality control or environmentally-friendly light practice in necessary stage process.

In the next subheading, comparative law research, which provides a detailed comparative analysis of key international frameworks, critically analyses the laws at international level as it links to light pollution control. The ideas of future model law on international or trans-boundary light pollution control are shaped by a comparative approach in response to the request of current environmental frameworks to promote and indicate sources of the light pollution provision. The future development of a more harmonised international system is also discussed by the comparative approach.

6.8 Approaching comparative light pollution law

Taking the comparative study of international environmental law between or among individual frameworks[386], represents a range of legislative reform benefits. While most

[386] Comparative law is able to set out how legislative reform of the international legal systems will make

of the international regulatory regimes are subject to maximum integration, there are some areas where the harmonisation and unification of international frameworks have not been established to promote joint outdoor lighting control. It would aim to introduce international environmental authorities with a clearer and simpler route for mitigating international or trans-boundary light pollution impacts. This research covers three main areas of international law reforms where lack of clarity can lead to inappropriate or non-environmentally friendly lighting in the wrong place at the wrong time.

Comparative international environmental law generally enhances the opportunities for the desired harmonisation and improvement of domestic laws. As mentioned above, areas of international environmental law which lacks of clarity and is outdated can raise particular legal problems as potential barriers to recognition and enforcement of light pollution control among the different nations and the different legal systems of the world. The Model Law on International Light Pollution Control would be necessarily adopted by international environmental bodies. All their Member States may give due consideration to the Model Law, in view of the integration and uniformity of the law of international or trans-boundary step processes and the specific needs of international or trans-boundary lighting practice. It may involve defining the common concepts and the fundamental principles of light pollution control to be undertaken, as well as designating the areas in which more detailed international or trans-boundary step processes should be adopted by domestic legal systems in particular.[387]

Alternatively, comparative law can help compare the ability of different solutions to solve the same light pollution problems, and spur on common means for protecting dark-sky or the night environment when scientific results demonstrated the interrelationship between light pollution and its adverse impacts.[388] In response to these

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light pollution law simpler and easier for international environmental bodies and domestic legal systems to harmonise or unify their international frameworks when increasing use of outdoor lighting has resulted in environmental problems. See Darpo, J. and Nilsson, A., 'On the Comparison of Environmental Law', *Journal of Court Innovation*, 2010 3 (1), pp 315-336.

[387] Shelton, D. and Kiss, A., *Judicial Handbook on Environmental Law*, United Nations Environment Programme, 2005, pp 79-82.

[388] Michaels, R., 'The Functional Method of Comparative Law', in Reimann, M. and Zimmermann, R. (eds) *Oxford Handbook of Comparative Law*, Oxford University Press, 2005, pp 340-381.

environmental problems, a single framework of the international environmental bodies on the protection of dark-sky or the night environment would be held at international level. The single international legally binding framework to deal with all aspects of light pollution on a broad international basis could be harmonised by an international environmental body if necessary. It may involve affirming the willingness to reinforce effective international cooperation to develop appropriate international instruments and by common means, such as definitions, fundamental principles, brightness or dark-sky quality management, for example, legally binding parties as well as settlement of future trans-boundary disputes.

Finally, light pollution needs to be considered at the same time as international and trans-boundary legal dimensions whilst the international jurisdiction has not adopted totally consistent approaches on all light pollution issues, filling the gaps by using separate instruments. International environmental bodies may offer the most effective approach for strengthening existing frameworks with regard to pollution provisions for environment protection. However, this approach will definitely present technical obstacles to some law reform because all current international environmental frameworks is not determined to promote relations and cooperation in the specific field of dark-sky protection and night environment preservation. Even though this is not easy, for all international environmental bodies may refer comparatively to preliminary discusses, analyses and commentaries to determine what ends the light pollution law may have been intended to promote, legislative actions taken to repeal, replace, or otherwise amend the existing international environmental frameworks since their enactment may be an alternative way of the international light pollution law development.

The comparative law analyses are discussed further in Chapters 8, 9 and 10. They especially examine further comparative views on whether to apply all aspects of light pollution to the international environmental bodies and domestic legal systems. They are to create a legal reform technique that will allow for both effective international and domestic application of the international light pollution law as mentioned above. They also provide how comparative law approaches can find the best solution of light

pollution problems to deliver alternative package of legislative reform and how international environmental bodies can make it simpler and easier for harmonising and unifying legal standards.

Chapter 7: European Union Light Pollution Law

There are many different types of light product standards[389] available for energy-using products and energy-related products under the existing European Union (EU) legislation. These EU legal benchmarks[390] can become increasingly important as issues gain energy and environmental prominence. However, one significant problem of European light pollution control is that the European legal regime does not specifically provide with a wide range of light pollution aspects when various kinds of light products create light pollution.

Chapter 7 asks why the EU should regulate a single light pollution framework, and how its existing regulatory framework could regulate, based on the contexts of the EU regulatory regime. The EU may need to be assured that outdoor economic lighting activities and some domestic household lighting activities will not damage human health and the night environment.

Therefore, Chapter 7 considers the impacts of light pollution on the European environment, energy, and climate change. Addressing the background and contexts of the European light pollution involves undertaking any existing light pollution resolution, common approach for combatting the harmful impacts of light pollution by taking EU regional measures to meet the objectives of harmonised light pollution control. This Chapter sets out the following concerns: to explore how a diverse range of environmental measures aimed at improving the quality of the dark-sky environment for

[389] Lighting product standards generally set out the requirements for the production, distribution, use and end-of-life management, but it does not set the criteria for governing the environmentally friendly lighting practices of ordinary light users on the functionality of light products. This means light users have rights to use their lights at night. This easement gives light users a freedom of the outdoor lighting through defined general application of directional luminaires and light controlling attachments on their facilities as well as premises, unless there is evidence that outdoor lights near to and above the horizontal or light intrusion within the open landscape impacts someone who have a right to live in a healthy environment under the European Convention on Human Rights (ECHR). Therefore, information requirements of inappropriate or non-environmentally friendly lighting practices will consolidate, clarify and strengthen the EU lighting-related products laws, which will make it easier for everyone to understand environmentally friendly lighting in the EU single marker will be stronger than ever. See Stock, A., *The Right to a Healthy Environment: How to use international legal mechanism for the protection of our environment and our health – A Manual, Women in Europe for a Common Future*, 2007, p 21.

[390] The EU legal benchmarks may set standards for both non-legally binding rules of lighting conduct and legally binding frameworks of lighting practices. See Trubek, D. M. and Trubek, L. G., 'Hard and Soft Law in the Construction of Social Europe: the Role of the Open Method of Co-ordination', *European Law Journal*, 2005 3 (11), pp 343–364.

European citizens and providing them with a high quality of outdoor light use should be adopted by the EU legal system and to examine how a common approach for combatting the harmful effects of light pollution should be taken by implementation and enforcement of the EU environmental legislation. Finally, it makes a critical analysis for developing the law with a comparative approach view to giving the EU appropriate law reform on the control of light pollution.

7.1 Background and contexts

Over the last 10 years light pollution problems have attracted increasing attention from European countries throughout the political institutes and environmental organisations, especially in EU Member States where their environmental governing authorities carry out scientific investigations on light pollution, but also in European countries where the current and predicted impacts of light pollution have been monitored and specified by their domestic legal systems. Whereas some environmental issues of light pollution have not been identified by the European region's environmental risk assessment[391], the complexity in how a lack of adequate prevention, protection and preparedness of the European light pollution control is specifically defined, and the uncertainty in the way regional light pollution risks should be identified, mean that European light pollution is seldom tackled by the European specific measures.

Outdoor lights which have significantly improved European citizens' outdoor night lives, shaping the night environment in today are necessary in European nations, to develop urbanisation, industrialisation and commercialisation. However, unwanted outdoor lights from the wrong light direction and inappropriate light intensities cause significant damage to the night environment.[392]

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[391] A widening in focus from reducing uncertainties of illuminating engineering technology and architectural lighting design innovations to coping with irresolvable uncertainties and complexities of the scientific lighting can help to avoid misunderstandings and undue expectations of the role and competence of light science. See United Nations Educational, Scientific and Cultural Organization, *The Precautionary Principle*, United Nations Educational, Scientific and Cultural Organization, 2005, p 28.

[392] While the EU generally purposes to protect all citizens from adverse effects of environmental harms, light pollution is not yet subject to any European legislative frameworks which can provide essential disciplines of light pollution and necessary steps to developing regional light pollution control. To

In some European nations, legal concern for the dark-sky quality in and around urban lighting areas or nocturnal conservation landscapes has been increasing during the early 21st century[393] and resulted in national laws followed ultimately by domestic legal systems. For example, the *Czech Republic's Protection of the Atmosphere Act 2002*[394] which becomes the first light pollution law in the European Union to regulate the way in which the Czech Republic's national government empowers local authorities to limit outdoor light pollution from streetlights and other outdoor light fixtures.

Currently, the use of any design, material or method of light pollution control is not harmonised at EU level and there are no specific EU plans for regional or trans-boundary development of light pollution control through coordination of the environmental and planning stage processes; however, the EU *Directive on energy-related products (ErP) (Directive 2009/125/EC)* as the key EU energy law relating to eco-designs, defines the regional provisions for setting eco-design requirements on light products as energy-related products and establishing requirements of the production, distribution, use and end-of-life practice of light products.[395] These factors mean that all the significant aspects associated with the light pollution control are not covered by the existing EU law.[396]

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improve the functioning of the regional cooperation and to enhance the regional light pollution control, the EU environmental and planning legislation would balance the interests of light users who may have had rights to light consumption and the interests of night environmental protections and dark-sky heritage to be committed to Member States' outdoor light practices and relevant stakeholders beyond what outdoor lights are appropriately used.

[393] Deketelere, K., 'Environmental Planning and Spatial Planning from a European Community Perspective', *European Environmental Law Review*, 1997 November, pp 307-317.

[394] Masaryk University's Department of Physics, *The Czech Act on Protection of the Air, including Light Pollution prevention*, available from http://amper.ped.muni.cz/light/law/czairlaw3.htm accessed 19 June 2014.

[395] European Commission, *Energy Efficiency: Eco-design of Energy-Related Products*, available from http://ec.europa.eu/energy/efficiency/ecodesign/eco_design_en.htm accessed 19 June 2014.

[396] Similarly, the urban expansion of district brightness areas is referred to a complex growth of the design, installation and maintenance urban outdoor light within urban boundaries. This phenomenon is necessary to incorporate urban lighting considerations into EU planning development because lighting with well planning regime has a positive effect on the urban nocturnal ecosystems and EU citizens who healthily live in urban or suburban location. The growth of urban lighting has numerous transportation and community safety benefits; nonetheless, urban light pollution from facility lights, commercial lights, industrial lights, and the other relevant urban outdoor lights can cause a number of adverse effects as

Even though urban light development is desirable, there are challenges to applying planning development standards in every European country. For urban light development to be energy-effective and environmentally proficient, the main EU planning law, such as the *European Landscape Convention 2000* (the Florence Convention)[397], may be reformed in a way that supports regional opportunities for effective energy-efficient urban outdoor lighting from an energy savings and an environmentally friendly installation and performance design.[398]

In addition, under a range of EU environmental legislation, each EU Member State has to be responsible for the adoption and implementation of EU measures for fulfilling their environmental obligations. The EU Member States may address all environmental pollution issues and prepare to control all aspects of pollution when scientific evidence of emerging issues on environmental risks to EU citizens' health and well-being from pollution[399] has been addressed by the EU environmental authorities. To ensure that the pollution subjects are addressed and environmental obligations pursuant to the EU law, each EU Member State may subject to the EU's environmental approval whereas it is necessary to lay down the necessary environmental step processes to be followed where provision should also be made for European regional and trans-boundary light pollution control by each EU Member States' jurisdictions. For example, the *Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora* or the Habitats Directive not only protects important habitat types (e.g. nocturnal species which are sensitive to light pollution)[400], but also provides an integrated approach to establish prevention from pollution harms to habitats.

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mentioned in the Chapter 2. Macrory, R., 'Environmental Citizenship and the Law: Repairing the European Road', *Journal of Environmental Law* 1996, 8 (2), pp 219-235.

[397] Council of Europe, *Council of Europe Observatory on the European Landscape Convention*, available from http://www.coe.int/t/dg4/cultureheritage/heritage/Landscape/default_en.asp accessed 23 May 2014.

[398] New York State Energy Research and Development Authority, *NYSERDA How-to Guide to Effective Energy-Efficient Street Lighting for Planner and Engineers*, New York State Energy Research and Development Authority, 2002, p 1.

[399] Henschel, S., and Gabrielle, C., *Health risks of air pollution in Europe –HRAPIE project: New emerging risks to health from air pollution – results from the survey of experts*, World Health Organisation Regional Office for Europe, 2013, p 1.

[400] Mohar, A., *LIFE Project Number LIFE 09 NAT/SI/000378 2nd Progress Report Covering the project activities from 16/06/2012 to 30/04/2013*, European Commission Life Programme and Ministry for Environmental and Spatial Planning of Republic of Slovenia, 2013, pp 1-31.

While new types of environmental pollution (i.e., light pollution and electrical pollution) impact on European citizens' everyday life, whether through the foreseen or unforeseen harms of pollution people face of the non-environmentally friendly practices, many kinds of EU legal frameworks are unavailable, or the EU law does not specifically provide maximum harmonisation to European Member States' domestic legal systems. This means all aspects of European light pollution have not been covered by EU environmental law. European integral approach has not been considered for delivering the maximum harmonisation, both of which would ensure that there is EU environmental law for conforming to current practices in European light pollution control and modern means of lighting with regard to the form of the EU light pollution agreement and the granting of specific environmentally- friendly lighting measures. This law is closely integrated with the proposed combined environmental regulatory functions and environmental law principles at the European Union level.

In the next subheadings, this research considers the extent to which European Union concepts of light pollution and EU law addressed Member States' responsibility for regional or trans-boundary light pollution at a European level. This research sets out critical evaluations demonstrating how European comparative law[401] could be used to apply and improve the EU energy, environmental and planning laws, in areas like light pollution control, lighting-related products, planning development, energy and climate change, to better serve its needs of integration and harmonisation.

7.2 Key concepts in the EU light pollution control

Introducing a new type of pollution would raise a difficult question about whether EU law would be justified under the Treaty on the Functioning of the European Union (TFEU). The TFEU has been developed from the Treaty establishing the European Economic Community (TEEC).[402] It, informally known as the Treaty of Rome, sets

[401] Taking into consideration the differences in the light pollution law and other relevant approaches between two regional jurisdictions, the analysis is able to impart some motives in order to employ an intergovernmental approach of light pollution control measures. See Germani, A. R., *Environmental Law and Economics in U.S. and E.U.:A Common Ground ?,* University of London School of Oriental and African Studies, 2004, p 1-20.

[402] See Borchardt, K., *The ABC of European Union law*, European Union, 2010, p 15.

several legal concepts of applying environmental law norms to gain a better understanding of European environmental law and meaningfully helps either in explaining how legal environmental rules evolve, or what might be the consequences of alternative environmental rules.[403]

Article 191 of the TFEU provides objectives and principles of EU environmental policy[404]: Article 191 (1) (2) (3) and (4) reads as follows[405]:

'1. Union policy on the environment shall contribute to pursuit of the following objectives:

– preserving, protecting and improving the quality of the environment,

– protecting human health,

– prudent and rational utilisation of natural resources,

– promoting measures at international level to deal with regional or worldwide environmental problems, and in particular combating climate change

2. Union policy on the environment shall aim at a high level of protection taking into account the diversity of situations in the various regions of the Union. It shall be based on the precautionary principle and on the principles that preventive action should be taken, that environmental damage should as a priority be rectified at source and that the polluter should pay.

In this context, harmonisation measures answering environmental protection requirements shall include, where appropriate, a safeguard clause allowing Member States to take provisional measures, for non-economic environmental reasons, subject to a procedure of inspection by the Union.

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[403] Germani, A. R., *Environmental Law and Economics in U.S. and E.U.:A Common Ground?*, available from http://www.cefims.ac.uk/documents/research-34.pdf accessed 23 May 2014.

[404] European Commission, *Workshop on EU Legislation Principles of EU Environmental Law*, European Commission, 2012, pp 1-19.

[405] Foundation for EU Democracy, *Consolidated Reader-Friendly Edition of the Treaty on European Union (TEU) and the Treaty on the Functioning of the European Union (TFEU) as amended by the Treaty of Lisbon (2007)*, Foundation for EU Democracy, 2008, pp 130-131.

3. In preparing its policy on the environment, the Union shall take account of:

– available scientific and technical data,

– environmental conditions in the various regions of the Union,

– the potential benefits and costs of action or lack of action,

– the economic and social development of the Union as a whole and the balanced development of its regions.

4. Within their respective spheres of competence, the Union and the Member States shall cooperate with third countries and with the competent international organisations. The arrangements for Union cooperation may be the subject of agreements between the Union and the third parties concerned. The previous subparagraph shall be without prejudice to Member States competence to negotiate in international bodies and to conclude international agreements.'

Although the main purpose of the TFEU is to simplify the European institutional structure and the decision-making process in order to boost efficiency, coherence and democratic legitimacy[406], it has not yet recognised a number of rights, concepts and principles that will apply to the EU Institutions, Member States and all relevant stakeholders when light pollution becomes an environmental problem in European countries.

With respect specifically to the protection of astronomical dark-sky heritage and the night environment, the absence of a specific legal basis in the TFEU has not prevented EU action in the field of non-environmentally friendly light or inefficiency lighting. While European environmental law has evolved over the years from a scattered and uncoordinated group of measures incidental to the overriding objectives of regulatory harmonisation and economic integration to a sophisticated and detailed system of environmental regulation and multilevel governance[407], no serious relevant stakeholders

[406] ClientEarth, *The impact of the Lisbon Treaty on climate and energy policy - an environmental perspective*, ClientEarth, 2010, p 2.

[407] Orlando, E., The Evolution of EU Policy and Law in the Environmental Field: Achievements and

can afford to be caught unaware of the EU's leading role in setting stringent light pollution requirements within the EU, nor in establishing astronomical and environmental standards that are of interest throughout the European legal systems.[408]

As referred to above, one potential problem is that the current legal basis for environmental policies generally covers several limits for key pollutants. It would seem to work best if applied in a broad way, focusing on protecting human health and the environment. While Article 191 of the TFEU is written in very general terms, the EU Institutions have not yet interpreted this as a term of controlling key elements of light pollution restrictively.

So far, there have been few EU institutions, agencies and bodies' responses to the light pollution problems highlighted in the EU body of treaties and relevant international obligations. The EU Parliamentary Assembly adopted a resolution on environmental terms of light pollution. The *EU Parliamentary Assembly Resolution 1776 (2010) on Noise and Light Pollution*[409], as a new resolution for updating and clarifying European light pollution concerns, has specifically stressed that they could address the European light pollution's concerns and employ the implications for the environment taken by the EU environmental authorities and EU Member States with a view to implementing the future step processes, in particular the EU provisions for combating the adverse impacts of light pollution by taking legal measures.[410] This means the *EU Resolution 2010* adopted regionally has concentrated a focus on some European light pollution problems that are harmful and non-environmental. Nevertheless, there is a wide gap between the theory of EU environmental law and the concerns of EU institutions, agencies and

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Current Challenges, available from http://www.transworld-fp7.eu/wp-content/uploads/2013/04/TW_WP_21.pdf accessed 28 May 2014.

[408] Jans, J. H. and Vedder, H. H. B., 'European Environmental Law: After Lisbon, 4th edn', *Journal of Energy & Natural Resources Law*, 2012 2 (30), pp 222-226.

[409] Parliamentary Assembly, *Resolution 1776 (2010) Noise and light pollution*, available from http://assembly.coe.int/Main.asp?link=/Documents/AdoptedText/ta10/ERES1776.htm accessed 28 May 2014.

[410] A new environmental pollution would follow the substance of the definition of risks to the environment and the significance of the environmental impacts in provisions of the EU law by stating that European region is being faced if various unwanted consequences of outdoor lighting in Europe can harm EU citizens' quality of life and interfere with nature of the environment, or if it is likely to have an effect on energy wastage.

bodies. For example, as mentioned in Chapter 6, the *UNESCO Starlight Declaration 1992* as a non-legal binding framework does not set international or trans-boundary obligations enforceable in European legal systems. Consequently, the EU Member States have never agreed to recognise the privileges and obligations in their domestic legal systems because national parties to the Declaration are not formally committed to develop and endeavour to put into their national or local legal regimes. Again, the EU is able to apply indirectly to light pollution, but it has legal limitations for dealing with all aspects of European light pollution. This means that the EU has not yet defined harmonised regulatory indicators (commonly used SI unit measurements for light pollution level) and environmental zoning for outdoor lighting control, and requires regular mapping of light pollution areas (notably around district brightness areas) as well as provision of information to the public. These failures in adequate identification of legal contexts of light pollution measurements (i.e., regulatory SI Unit metrics, enforceable scales, and measurable degrees) can be considered to be both environmental and energy problems. However, by giving legislators and policy makers a more detailed understanding of regulatory light pollution metrics, environmental bodies both at European level may establish objectives focused on a comparison between illuminating engineering metrics and other pollution metrics. For example, to allow them to more easily compare the measurements of light pollution and noise pollution offered by SI Unit metrics, they may set the levels of unacceptable auditable decibel (dB)[411] and inappropriate visual luminance in (lux)[412] with respect to the most acceptable or environmentally friendly degree offered on both pollution measurements. This standardisation will empower legislators, policy makers, and other relevant stakeholders to better compare measurements of light pollution for law reform both European and cross- Europe borders. If a large proportion of the European population living in big agglomerations is affected by key elements of light pollution above the level considered

[411] Weissenberger, J., *New rules on EU airport noise restrictions*, Library of the European Parliament, 2013, pp 1-5.

[412] Navara, K. J. and Nelson, R. J., 'The dark side of light at night: physiological, epidemiological, and ecological consequences', 2007 (43) *Journal of Pineal Research*, available from http://www.environmentalhealthnews.org/ehs/news/pdf-links-2014/Navara%20and%20Nelson%202007.pdf accessed 28 May 2014.

as safe by the European environmental bodies,[413] the EU may focus on the reduction of potential adverse consequences of non-environmentally or inappropriate levels of outdoor light for human health, the night environment, dark-sky heritage and economic activity through the considerable level of different legal measurements that will be brought forward by legislators and policy-makers regionally, within the EU and its Member States.

Furthermore, many types of environmental pollutants are fully compatible with the secondary sources of EU legislation, such as regulations, directives, decisions, opinions and recommendations, and other forms of law. However, part of the legal problem may be that light pollution law as an astronomical or environmental concept influenced illuminating engineering philosophy, but the attitude to other similar pollution problems has never been clarified. Of course, the EU Institutes and Member States may simply have used each name of pollutant to classify several different types of pollution, for example, air pollution, water pollution, soil pollution, noise pollution, radioactive pollution, thermal pollution, oil pollution and electrosmog pollution. By contrast, each type of pollution may be recognisable by the EU Institutes and Member States to which it has been affixed as indicating that they are of the same need to identify environmental quality metrics, finer degrees of resolution, reliable measurements for comparison and measurable levels. They may fulfil an important role in answering questions such as how will levels of acceptable environmental quality change in the future? Which are the most important emission sources to control to reach acceptable environmental quality? and what balance should be struck between policy actions within the EU and abroad?[414] A key objective of a European pollution control regime is to benchmark the levels of pollutants with environmental objectives and based on these levels establish a proportionate regime or system for the assessment and management of acceptable environmental quality going forward.[415]

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[413] Guarinoni, M., Ganzleben, C., Murphy, E., and Jurkiewicz, K., *Towards A Comprehensive Noise Strategy*, European Parliament's Committee on Environment, Public Health and Food Safety, 2012, p 8.

[414] Department for Environment, Food and Rural Affairs, *Fine Particulate Matter (PM2.5) in the United Kingdom*, Department for Environment, Food and Rural Affairs, 2012, p 123.

[415] European Commission, *Guidance on the Commission Implementing Decision laying down rules for*

So, it is legitimate to compare acceptable and unacceptable levels of different pollutants with a reasonable degree of environmental protection. For example, the *Directive 2002/49/EC of the European Parliament and of the Council of 25 June 2002 relating to the assessment and management of environmental noise* gives public information about acceptable and unacceptable noise metrics which have been harmonises across all of EU Member States, suggesting Lden (day-evening-night equivalent level) as an appropriate metric to assess annoyance and Lnight (night equivalent level) as a metric to assess sleep disturbance.[416] Additionally, the EU legislation on noise emitted by equipment, formally known as the *Directive 2000/14/EC on the approximation of the laws of the Member States relating to the noise emission in the environment by equipment for use outdoors*, also harmonise the provisions of the Member States relating to noise emission standards, conformity assessment procedures, marking, technical documentation and collection of data concerning the noise emission of equipment for use outdoors, such as construction machinery and lawnmowers, with a view to contributing to the smooth functioning of the internal market, while protecting human health and well-being.[417] By contrast, there is no harmonisation of the acceptable and unacceptable outdoor light metrics across all of EU Member States. The lack of attempt to harmonise measurable degrees of light pollution in the EU makes this area difficult enough for regulatory light pollution control because EU environmental law is unclear why day-evening-night light level of outdoor light is excluded as this environmental issue impacts on human health and the night environment. The appropriate metric to assess excessive levels of artificial light annoyance and sleep disturbance may fall within EU law, which is a large and varied set of environmental and planning rules.

A further question to be considered is whether the opportunity should be taken to

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Directives 2004/107/EC and 2008/50/EC of the European Parliament and of the Council as regards the reciprocal exchange of information and reporting on ambient air (Decision 2011/850/EU), European Commission, 2013, pp 21-22.

[416] World Health Organization, *Burden of disease from environmental noise Quantification of healthy life years lost in Europe*, Regional Office for Europe of the World Health Organization & JRC European commission, 2011, p 5.

[417] Guarinoni, M., Ganzleben, C., Murphy, D. and Jurkiewicz, K., *Towards A Comprehensive Noise Strategy*, European Parliament's Committee on Environment, Public Health and Food Safety, 2012, pp 35-36.

consider whether general principles of EU environmental law need to be, and could be, extended, to harmonise the rules of the Member States relating to outdoor light standards, conformity of environmentally friendly light assessment procedures, environmentally friendly light product labelling, technical light pollution control documentation and collection of data concerning the atmospheric sky glow emission of outdoor light at night, such as street lights and security lights, with a view to contributing to the smooth functioning of the European economic market, while protecting human health and the night environment. The lack of these outdoor light standards in EU environmental law can be problematic for all relevant stakeholders who remain in polluted areas. One possible approach for these environmental concerns might be to abandon several limitations of EU law. The concepts of indentifying environmental quality metrics, finer degrees of resolution, reliable measurements for comparison and measurable levels of outdoor light may be merged into a single directive.

A full exploration of these concepts would require an understanding of what it is to be a single light pollution directive, what it is to be a nature of the EU's regulatory regime, the relation between the two concepts, and an inquiry into the nature of the EU in terms of harmonisation of light pollution control.[418] Firstly, an EU light pollution directive may be a single legislation that sets out an aim of light pollution control that all EU Member States must achieve.[419] It may be derived from the main concepts of environmental law set out in the Treaties and may include key concepts of global light pollution control.[420] It might constitute an important step forward in harmonising environmentally friendly lighting criteria and the content of dark-sky environment protection at EU level. Secondly, the nature of the EU's regulatory regime is conceptualised within a paradigm that posits the existence of philosophy of European supranationalism designed to improve economic single market efficiency and prevent

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[418] Dickson, J., *Towards a Theory of European Union Legal Systems?*, available from http://www.law.ox.ac.uk/denning-archive/news/events_files/Dickson.pdf accessed 3 June 2014.

[419] European Union, *Regulations, Directives and other acts*, available from http://europa.eu/eu-law/decision-making/legal-acts/index_en.htm accessed 3 June 2014.

[420] European Commission, *Monitoring the application of Union law*, available from http://ec.europa.eu/atwork/applying-eu-law/index_en.htm accessed 3 June 2014.

environmental conflicts.[421] This regime generally contains a European legal system that promulgates legislation that, inter alia, creates new primary and secondary rules that impose obligations upon the Member States.[422] It also wishes to have a merger of regulatory methods of measuring environmental pollutants required under the European secondary rules into a single harmonised standard.[423]

As shown in previous Chapters, light pollution is a serious threat to human health and ecosystems, both through direct effects from the emitted lights but more seriously through the atmospheric smog of light pollution formed in the urban atmosphere. A single legislation to improve dark-sky quality and the night environment may be put in place which better results in improving environmentally friendly lighting quality. In other words, this research agrees that a clearer, simpler and more accessible EU framework of non-environmentally friendly lighting control should lead to better awareness of European light pollution problems.

Therefore, this research need to specify details about how that the EU legislation is delivered[424], which it can leave to the foundation aspects of EU environmental law, which are discussed below. The energy, environmental and planning measures should specify, however, that it commits EU Member States to contribute[425] to varying light pollution control mechanisms and to the European sustainable lighting practices. The

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[421] McCormick, M. J., *A Primer on the European Union and Its Legal System*, available from https://www.hsdl.org/?view&did=445432 accessed 3 June 2014.

[422] Jones, M. L, 'The Legal Nature of the European Community: A Jurisprudential Analysis using H.L.A. Hart's Model of Law and a Legal System', *Cornell International Law Journal*, 1984 1 (17), pp 4-59.

[423] Institute for European Environmental Policy, *Manual of European Environmental Policy*, Institute for European Environmental Policy, 2014, pp 1-7.

[424] In addition to specific European environmental protections governing light pollution, a common approach for combating the harmful effects of light pollution by taking European regional or trans-boundary lighting requirements will need to be met by EU institutions, agencies and bodies, which they will sight to address certain environmentally friendly lighting practices perceived to be detrimental to EU lighting-related product consumers and to integrate environmental protections for EU citizens from light pollution by international light pollution law and European energy, environmental and planning frameworks. While some of the light pollution issues are raised in some EU Member States' domestic legal systems and they addressed specific measures in their jurisdictions under national laws, the EU have not been applicable in the European context due to differing Member States' energy, environmental and planning law regimes and several factors of each European nations, for example, geography, politics, economy, demographics and culture.

[425] Kramer, L., *Focus on European Environmental Law*, Sweet & Maxwell, 1992, p165-167.

threat of European light pollution presents various critical questions that must be resolved on the grounds and context of EU energy, environmental and planning law.

Where there are threats of serious or irreversible light pollution impacts at European level, lack of full scientific certainty should not be used as a reason for postponing such regional precautionary or preventive approaches. So, this raises useful questions as to the necessity of such European measures and their ongoing EU law reform. They would give the EU institutions, agencies and bodies more certainty in how they respond to light pollution problems, by providing a single regulatory framework which may better reflect the European light pollution control engaged in both regional integration as well as maximum harmonisation.

The legal system of the European Union, which contains centrality of the regional legal mechanism, includes a number of examinations of the legal issues surrounding the energy, environmental and planning aspects. A number of EU legal instruments adopted many harmonised standards and developed various integrated step processes for intergovernmental cooperation. They also provide a standardised set of provisions designed to enable EU legislative bodies, EU environmental governing bodies, Member States engaged in EU legal adoption and implementation, as well as other relevant stakeholders of the EU legal system. The EU recognises the importance of carrying out its role in a purpose way of integration and harmonisation of the European legislation. It generally establishes its legal materials following detailed regional or trans-boundary cooperation, consideration of the joint Member States' legal issues and shared energy, environmental and planning concerns following the EU publications of consultation papers.

The EU provides a number of different legal sources of EU legislation. The official legislative frameworks or authoritative statements of EU law responded to the energy, environmental and planning aspects with two sources: the primary source of EU legislation refers to EU Treaties; the secondary source of the EU legislation refers to the regulations, directives, decisions, opinions and recommendations, and other forms of

law.[426] In such instances, all types of the secondary sources have to be based on the EU Treaties and the secondary sources need to be committed to include the subsequent aspects of the EU Treaties in order to ensure that the EU and its Member States are not left even further behind in the common standardisation into the EU legal regime.

Therefore, the secondary sources of the EU law may be needed within the EU Treaties to ensure that impacts of light pollution relating to energy, environmental and planning concerns such as glare, sky glow and intrusiveness, but also other aspects of unwanted or non-environmentally friendly lights, are not neglected in the Member States' domestic legal systems. The impacts of European light pollution might lead the EU to pursue environmentally friendly lighting practices under the existing primary and secondary sources of the EU law.

The EU is also seeking further views on whether to apply all the environmental pollution harms to its environmental governing bodies and the Member States. However, the secondary sources of the EU legislation have not extended some of environmental aspects to light pollution control. Also under the key primary sources of EU law, all aspects of light pollution control law have not been interoperated by the European Court of Justice (ECJ) when EU citizens have been victims of European or trans-boundary light pollution.[427] Again, the ECJ has not clearly interpreted EU energy, environmental, and planning law to make sure that a range of light pollution is taken by

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[426] Alford, D. E., 'European Union Legal Materials: A Guide for Infrequent Users', *Law Library Journal*, 2005 97 (1), pp 49-79.

[427] Light pollution cases are able to make their way directly to the ECJ in a number ways, for example, the EU commission or a Member State may bring light pollution infringement proceedings against Member States for a failure to fulfil an environmental obligation under energy, environmental, and planning requirements for the EU lighting standard application and the ECJ has jurisdiction to establish that an EU institute has failed to order any necessary measures of light compliance with the EU lighting requirements. Alternatively, the light pollution cases are able to reach the ECJ through preliminary references from the courts of Member States under the EU judicial law. Likewise, when the EU legal regime or Member States' legal system have acquired judicial rights over their context of light pollution problems or conflicts, other judicial stakeholders will be able to learn from that the relevant energy, environmental and planning context, but may be unable to use them for further European or trans-boundary light pollution problems or conflicts unless relevant decisions can be ruled by the ECJ. See Sands, P., 'European Community Environmental Law: Legislation, the European Court of Justice and Common-Interest Groups', *Modern Law Review*, 1990 53 (3), pp 689-698.

the European considerations in respect of the EU regulatory approaches.[428] Beyond EU law, there are three key European challenges which specialise in light pollution problems. Firstly, despite there being a range of international or trans-boundary light pollution conflicts between EU governments and EU institutions, the EU light pollution measures have not been exhibited by failing to adopt all the necessary and appropriate measures to ensure that all sources of unnecessary or inappropriate outdoor lights will not be operated in accordance with the conditions laid down by the primary or secondary sources of the EU law. Secondly, when the lack of the necessary step to comply with the European court ruling affirming various aspects of the European light pollution under existing EU regulatory frameworks related to misdirected lights or inappropriate illumination such as the legal recognition of European energy efficiency standards for lighting products and other relevant lighting standards is particularly significant, there are no obvious means to clarify the judicial boundaries of European light pollution in the new circumstances which international or trans-boundary light pollution stakeholders creates. Thirdly, although some European Member States do have specific light pollution legislation directed at controlling key elements of light pollution as mentioned in Chapter 8, there is no European harmonised indicator expressed in the EU legislation. From the scientific point of view the best criterion for choosing an outdoor lighting indicator, as mentioned in Chapter 2, may be its ability to predict a European effect. For example, long-term effects, such as human health problems, are more correlated with outdoor lighting indicators summarising the light pollution situation (i.e., obtrusive light measurements for outdoor lighting fixtures and design) over a long time period, such as yearly average of level of light pollution in district brightness areas, while instantaneous effects such as sleep disturbance are better with the maximum level per lighting event, such as intrusiveness of outdoor light that is

[428] Furthermore, the obligation to act arises from the EU law; in particular from the relevant directive and a number of the EU regulatory frameworks require Member States to perform certain harmonised pollution control. Likewise, the provisions may not be directly applicable in accordance with the EU legislation if the EU and its Member States fail to draw up such relevant directive on specific pollution control. The EU, therefore, sets specific harmonised standards and its Member States is accordingly required to provide for legal consequences to ensure that the EU provision are applied in the field of specific pollution harms. See Kramer, L., 'The implementation of Community Environmental Directives within Member States: Some Implications of the Direct Effect Doctrine', *Journal of Environmental Law*, 3, pp 39-56.

allowed to illuminate or intrude upon areas not intended to be lit.[429]

In order to represent a great opportunity to benefit clarity of the judicial boundaries of European light pollution, most of the fundamental principles of the EU law are subject to critical reviews on how the EU law applies to all aspects of light pollution. The EU generally employs various specific needs of different legal aspects of the pollution control laws while remaining governed by common principles of environmental law[430], for example, the sustainable development principle, prevention principle, precautionary principle, polluter-pays principle and cooperation principle, as mentioned in Chapter 5. A maximum harmonisation regime, embracing various environmental pollution control frameworks based on environmental law principles, is critical to the success and growth of the EU integration and cooperation.[431]

EU harmonisation is a unique regional standard elaborated on the basis of a request from the European Commission to recognised EU institutions, agencies and bodies to develop a European standard that provides solutions for compliance with a legal instrument.[432] This is a good starting point for the consideration of European harmonisation arising from EU secondary law as a legal instrument. Under the EU legal regime, EU institutions, agencies and bodies are required to remove barriers which prevent EU citizens and their regional market from potential consequences of an environmental hazard combined with their probabilities, environmental matters that may lead to harm or cause adverse affects, and limits in knowledge about environmental

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[429] Similarly, from the scientific results or precautionary concerns the best criterion for choosing a noise indicator is its ability to predict relevant adverse impacts of outdoor noise pollution. So, for various health end points, different SI metrics and relevant enforceable measurements have been chosen by the EU. For example, decibel (dB) metrics should also be easy to explain to the public – intuitively understandable, avoiding unnecessary breaks with European practice and enforceable. See World Health Organisation, *Night Noise Guidelines for European*, WHO Regional Office for Europe, 2009, p X.

[430] Sadeleer, N., 'Environmental Principles, Modern and Post-modern Law', in Macrory, R., Havercroft, I. and Purdy, R. (eds) *Principle of European Environmental Law: Proceedings of the Avosetta Group of European Environmental Lawyers*, Europa Law Publishing, 2004, pp 223-236.

[431] Rehbinder, E., 'Legal Integration in Federal Systems: European Community Environmental Law', *American Journal of Comparative Law*, 1985, 33, pp 371-446.

[432] European Commission, *Harmonised standards*, available from http://ec.europa.eu/enterprise/policies/european-standards/harmonised-standards/index_en.htm accessed 3 June 2014.

problems and the technological factors that influence them. Accordingly, the EU institutions, agencies and bodies had stepped beyond its competence to harmonise Member States' domestic laws which is granted by EU Treaty as a primary source of the EU law. This may have consequences for EU citizens living in the Member State jurisdictions, but also for the wider relevant parties[433], depending upon mutual recognition. In order to minimise risks and ensure legal certainty across Member States, EU legislation harmonising legal instruments[434] have been introduced, in particular in a key series of risks that have the potential to cause harm to animals, humans or the environment. So, European rules of light pollution control may need to be adjusted to mitigate potential harms and to strike the balance between strengthening outdoor lighting requirements in a way that is consistent with European legal regimes by striking a fair balance between environmental risk among European citizens and light pollutants and allowing EU Member States to provide sustainable use of outdoor light.

The EU legal and political instruments, such as regulations, directives, decisions, recommendations, communications, action programmes, resolutions, environmental agreements and tri-parties agreements, are able to harmonise European light pollution control but are also forced to limit light pollution arising from non-environmentally friendly or inappropriate light emission. To create a number of harmonised light pollution control measures in Europe, restrictions on lighting practices must be established as much as possible, while creating an environment favourable to effective energy-related products, environmentally friendly lighting practices, and the night environment protection. Protecting and improving the night environment is an important part of achieving light standard harmonisation in Europe. Furthermore, accessing a range of necessary and proportional processes to reduce, eliminate or mitigate light

[433] The single market of the EU regime is all about bringing down barriers and simplifying existing rules to enable everyone in the EU – individuals, consumers, businesses and authorities – to make the most of the harmonised standards offered to them by having direct access to 28 countries and 503 million people. Exercises of the single marker can help to serve international trade, concerning product, environmental harms, and energy-related risks, but also set a relatively high level of trade integration relative to trade with other countries or parts of the world. See Hix, S. and Jun H. W., *An East Asian Single Market?: Lessons from the European Union*, Working Paper for the Korean Institute of International Economic Policy (KIEP), Seoul,30 March 2005.

[434] Kramer, L., *EU Environmental Law*, 7th edition, Sweet & Maxwell, 2012, pp 48-66.

pollution risk may rely upon following a view on the performance of existing European energy, environmental and planning measures that, if they were to fail, may increase the potential for tackling European light pollution.

Aware of the growing importance of European light pollution, this research sought out the EU energy, environmental and planning law that would contribute to the future light pollution law reform as mentioned in Chapter 8 and 9. In our growing knowledge-based light pollution, the EU law is important not only for promoting future reform of harmonised measures, but also for amending existing European measures and replacing them with the new aspects of light pollution. If current EU measures do not cover all aspects of light pollution, all sources of light pollution may be controlled at EU level by means of maximum limits on their energy, environmental and planning practices in the future, and are subject to very specific controls of light use, in the public interest[435] of environmentally friendly lighting practices.

7.3 Applying the EU legislation to light pollution

Currently, the aim for the EU high level of protection and improvement of the quality of the environment is to contribute to energy, environmental and planning growth and impacts, the EU law must be transposed into Member States' national law by legally binding obligations between the EU and its Member States concerning implementation of the EU environmental provisions. There are two main choices if the EU Member States comply in favour of European harmonisation standards, as all Member States standards could be the same, either by setting a higher standard, or by maintaining an

[435] Sky glow that hangs over Member States' urban brightness areas at night occurs from outdoor human-made sources of light. Emission of light pollutants travels over long atmospheric distances and trans-boundaries. There are various relationships exist between the adverse impact of light pollution on the night environment, such as dark-sky loss, nocturnal ecological damage, energy wastage and public interest in EU citizens' health. When something at light pollution issues is internationally considered for shared environmental damage, the EU could set extensive laws, regulations and enforcement authority over all light uses in Europe to protect EU citizens from light pollution harms. However, the EU law does not allow us to use more of special treatment on the more complex or challenging risks of light pollution at urban brightness areas of public interest and less on unnecessary or inappropriate lights which involve low or modest environmental risk, and are of limited public interest. See Larsson, M. L., *The Law of Environmental Damage: Liability and Reparation*, Kluwer Law International, 1999, p 403.

existing domestic standard (i.e., the EU may adopt harmonised outdoor light indicator as defined by European legislation). Setting a higher standard will considerably increase legal certainty for both gap-filling and further legal development in the Member States' jurisdiction. However, maintaining an existing domestic standard seems to be a more fair approach to accounting for better legislative reforms which can be taken forward in the Member States' domestic law.

Member States' energy, environmental and planning law is mainly set out in the national regulatory frameworks. These have been established to implement EU legal and political instruments which have the intention of integrating and harmonising various legal aspects of environmental quality management and pollution control across European region. Obligations of Member States to apply the EU law, either by Treaty provisions or secondary legislation will generally be aligned by domestic legal systems of the Member States. In a number of circumstances, a transposition of energy, environmental and planning aspects into Member States' law will fall within the exceptions to implementation and application, depending on legally binding requirements, the uses for which Member States are committed, or other relevant factors. If Member States wish to prevent light pollution, for example applying the urban brightness areas extent and assessing environmental risks in these spatial planning areas they may need to transpose from the energy, environmental and planning provisions of the EU law if none of the domestic law applies. For this reasons, a transposition of the EU law is essential where the Member States complies with regulatory sources of the EU law.

Since the EU legal regime had to attain a high level of European environmental protection with regard to each obligation of Member States to apply the EU law, often relying on two main sources of legislation, in many cases the direct or indirect measures of light pollution control are involved. Firstly, within the European legal regime of the EU, Member States are bound by the Treaty provisions via the system of Community law system, but this does not mean that they would have to adopt in their national legislation when the aim of attaining a high standard of light pollution control is

incorporates into the other domestic frameworks pursued at a national level.[436] Secondly, the secondary laws in the EU deal simultaneously with environmental quality and pollution control, which is a major difference compared to the Treaty provisions as primary source of the EU law. They consist of a number of legal instruments, for example, the regulations, directives, decisions, opinions and recommendations, and other forms of law, as mentioned above.[437] Implementation of each secondary source, however, is determined by a much broader range of adaptation than a single dominant adaptation which requires the EU and its Member States to adopt secondary sources in this field. For example, there are two main differences between application of regulation and application of directive: a regulation is directly applicable and tends to involve a number of specific environmental approaches, requiring Member States to take action about a specific environmental concern. A directive, on the other hand, needs to be implemented by Member States. The Member States' domestic legal systems generally outline the duties and responsibilities of the various environmental governing bodies consistent with their national frameworks and provide for the delivery of the outputs required by the EU directives.

The objective of the European legal system is to protect environmental interests of Europe and Member States while harmonising the legal standards of the single market.[438] This means that, even in the absence of any specific European light pollution control regime, the European legal system may apply different types of primary and secondary sources of the EU law to lay down current energy, environmental and planning rules on environmentally friendly lighting for both sources of light and quality of lighting practice.

While the EU recently established in preliminary approaches that the region of Europe is particularly affected, in environmental terms, by light pollution under the *EU Parliamentary Assembly Resolution 1776 (2010) on the Noise and Light pollution*, there

[436] Kramer, L., *EC Environmental Law*, 6th Edition, Sweet & Maxwell, 2007, p 418.

[437] Department for Business, Innovation and Skills, *Transposition Guidance: How to implement European Directives Effectively*, Department for Business, Innovation and Skills URN 11/775, 2011, pp 6-14.

[438] Lee, M., *EU Environmental Law: Challenge, Change and Decision Making*, Hart Publishing, 2005, pp 269-270.

are no other secondary sources of the EU law that directly involves a range of region and trans-boundary light pollution control (which is rather the secondary source than the Resolution 2010, as noted above).

Alternatively, EU institutions, agencies and bodies may give a feel for how the legal aspects of light pollution prevention derived from a number of principles of the current EU energy, environmental and planning provisions can be applied to set up useful step processes of light pollution control. Some EU frameworks that are presented as energy, environmental and planning practices on outdoor lighting control might enable the EU and its Member States to designate outdoor light sources and urban light uses for which they are the energy, environmental and planning bodies, as environmental zones for outdoor lighting control are within their environmental strategies.

A number of relevant EU legal mechanisms that are available to ensure lighting quality set out the maximum harmonised requirements for involving Member States in seeking positive improvements in the quality of lights, night or dark-sky environment, as well as in stakeholders' quality of lighting practices. These have two important consequences.

Firstly, many provisions of the Treaty on European Union (TEU) and the Treaty on the Functioning of the European Union (TFEU) [439] (formerly named the European Community (TEC) and recently amended by the Treaty of Lisbon) [440] make a number of environmental provisions with respect to energy, environmental and planning aspects of European environmental protection. They have effect for the sustainable purpose of making such provision as is necessary in order to comply with energy, environmental and planning problems. As content of the proposed EU Constitution, all Member States

[439] Foreign and Commonwealth Office, *A Comparative Table of the Current EC and EU Treaties As Amended By the Treaty of Lisbon*, Her Majesty's Stationery Office, 2008, pp 15-16.

[440] Under the Treaty of Lisbon, the EU should work for the sustainable lighting development of Europe based on balanced economic growth and environmental suitability, a highly effective single market regime, aiming at a high level of dark-sky protection and improvement of the quality of the night environment. This means that, even in the absence of any secondary sources of the EU light pollution law, EU institutions, agencies and bodies should carry out with responsibility for relevant primary sources of the EU law, such as provisions of the TEU and TFEU, across the Member States' jurisdictions with the intention to have regional and domestic light pollution prevention. See Foreign and Commonwealth Office, *Consolidated Texts of the EU Treaties as Amended by the Treaty of Lisbon*, Her Majesty's Stationery Office, 2008, p 5.

may apply many aspects of fundamental principles of the EU Treaties to their domestic legal frameworks when consideration of potential light pollution harm and uncertainty of illumination technology has taken place.

Secondly, Member States may be more effective in the possibility of implementing relevant secondary sources of the EU law, fully, by means of light pollution prevention than most other world communities. They are able to fully transpose the relevant EU regulations or directives in particular light pollution cases. Perhaps the most challenging step in transposing various European legal aspects is to implement their energy, environmental and planning measures. If Member States are considering implementing or applying an essential framework with regard to all outdoor light pollution, they will be finding out how essential measures of the relevant European frameworks minimise the potentially obtrusive direction from outdoor lighting installations, reduce inappropriate lighting level from urban brightness areas, improve the dark-sky atmosphere through a ban on upward lighting and increase significant illuminating technologies to reduce light pollution. Knowing what is or is not covered by the EU law may assist Member States in deciding whether or not to apply EU law. Accordingly, the existing EU law in relation to light pollution elements can bring in EU measures and incentives to reduce and mitigate various particular opportunities for light pollution harms at an effective law reform of each Member State in which a more balanced approach to the effectiveness of measures and the practices of environmentally friendly lighting has been adopted. For example, The *Ecodesign of Energy Related Products Directive 2009/125/EC* and the *Commission Regulation (EC) No 245/2009* concerns the ecodesign requirements for fluorescent lamps without integrated ballast, for high intensity discharge lamps, and for ballasts and luminaires. To be able to operate such lamps means potentially establishing the minimum standards[441] of energy efficiency for the proposed general and specific light sources, such as light products, the life-cycle of light products, and an eco-labelling regime, to reduce a significant environmental

[441] Hedmann-Robinson, M., *Enforcement of European Union Environmental Law: Legal Issues and Challenges*, Routhledge-Cavendish, 2007, p 19-21.

impact within the European single market.[442]

While most Member States successfully transpose their EU law commitments by which they are legally bound, some Member States have only partially transposed the EU directive in many environmental, energy and planning cases and some Member States fail to comply with energy, environmental and planning standards of the primary and secondary sources of the EU law.[443] Additionally, a number of issues in the measures or incentives of the EU light pollution control have fragments. Each EU framework relating to light pollution entails different objectives and concepts of energy, environmental and planning aspects when each primary or secondary source of EU law, in terms of the purpose of light pollution control, has not been aimed at providing specific measures or incentives. The fragmentation of the supranational regulatory approaches could be derived from non-harmonised European legislation as well as non-integrated standardisation, thus making it difficult for the EU legal regime difficult to draw up a more effective control of light pollution at European or national levels.

7.4 Problems with current EU law on lighting practices

Most EU institutions, agencies and bodies are not content to ensure EU legislation to resolve and minimise various risks of light pollution by referring to European light pollution control regime. This means that the EU legal system has not recognised that EU law requires manufacturers, industries, businesses, local authorities and European citizens to bring forward a single legislative proposal to make light pollution control clearer and thereby help promote sustainable lighting practices in Europe. Additionally, current EU law does not protect the night environment, dark-sky atmosphere and human well-being by ensuring that all key EU institutes (e.g. the European Parliament, the Council of the European Union or the European Commission) give consent for certain stage processes to proceed, make multi-criteria decisions and adaptive management in the urban brightness areas or dark-sky conservation landscapes of any likely significant

[442] Institution of Lighting Professionals, *Guidance on current and forth coming legislation within the lighting sector*, Institution of Lighting Professionals, 2011, p 5.

[443] Falkner, G.et al, 'Non-Compliance with EU Directives in the Member States: Opposition through the Backdoor?', *West European Politics* 2004 27 (3), pp 452-473.

effects on the environment. This subheading will explore potential legal issues concerning the introduction of light pollution law into the EU legal system, discussing how the EU could approach energy, environmental and planning concerns, and identifing possible responses to the European light pollution concerns. It also emphasises that the reform of a single European light pollution framework could be made to support the control of light pollution in the European and it also introduces various aspects of essential stage processes, committed by Member States, that need to coordinate and synchronise with other relevant EU energy, environmental and planning frameworks.

The increasing awareness of various light pollution problems facing the European countries' natural dark-sky environment has prompted many European stakeholders to show more interest in preserving the dark-sky environment when raising the risk of unnecessary outdoor lighting as part of a European pollution problem. Even though some EU institutions, agencies and bodies help raise European awareness of the risks of inappropriate outdoor lights, European citizens have not been fully protected by the EU law. Therefore, whilst it may be good outdoor lighting practice for many Member States to be responsible for enforcing a wide range of domestic law in relation to light pollution control and for introducing environmentally friendly lighting where essential, this research sees a lack of harmonised measurements (i.e., the measurable or enforceable Candelas (Cd/m2) , Lumens and Lux metrics of the International System of Units (SI) for outdoor light pollution emittance measurement) and stage process cooperation needed in making secondary sources of EU law compulsory and binding, especially as this would be out of step with EU treaties' environmental requirements at a European level. Again, a key difference with light pollution is that outdoor light sources are able to occur anywhere and usually do not have fixed control measures in outdoor areas, whereas roads, highways, sports grounds, industrial sites and public facility premises have light infrastructure at fixed locations and can be better planned for in terms of light pollution abatement at European level.[444] For measurement

[444] European Commission DG Enterprise and Industry, *Study on the experience in the implementation and administration of Directive 2000/14/EC relating to the noise emission in the environment by equipment for use outdoors, European Commission DG Enterprise and Industry*, European Commission DG

purposes, outdoor lights may be emitted at their highest allowable level by outdoor light premises. In case of exceeding the highest allowable level for designated use of the sources of the outdoor light, annoyance effects and health impacts could be calculated and valued monetarily, resulting in monetary values per person illuminated per illuminating engineering metrics for different light levels. The standardisation of an allowable level of outdoor light is also linked to specific concentration thresholds as well as the population within each the environmental zones for exterior lighting control within Member States' urban development plans.[445] Outdoor light at night offers important public interest benefits, but permissible environmentally friendly levels of outdoor light emission are needed to ensure public health and to help clarify the most cost-efficient ways to balance between urban light development and public health benefits. If EU law provides measurable metrics for the effects of mixtures of light pollutants from a variety of dark landscapes and district brightness areas, the metrics will accurately reflect the health and welfare impacts across Europe.[446]

It is widely recognised that inadequacy of EU light pollution legislation encourages the growth of outdoor light pollution by making the main elements of urban light pollution for Member States more difficult and complicated to prevent natural dark-sky heritage and nocturnal environment for European citizens. It rests on key European and trans-boundary legal issues associated with the relevant EU energy, environmental and planning frameworks, as outlined in our previous critical discussion which provides an analysis of the EU law and the practical light pollution problems arising in the application of these legal instruments as well as existing obligation of Member States.

The EU energy, environmental and planning frameworks associated with light pollution problems have been evolved over many years, through non-harmonised rules of light pollution prevention. This research will address these legal problems of the EU law in the following five key ways.

Enterprise and Industry, 2007, p 117.

[445] European Commission, *Implementation of ambient air quality legislation*, available from http://ec.europa.eu/environment/air/quality/legislation/assessment.htm accessed 3 June 2014.

[446] Waitz, I., Townsend, J., Cutcher-Gershenfeld, J., Greitzer, E. and Kerrebrock, J., *Report to the United States Congress Aviation and the Environment: A National Vision Statement, Framework for Goals and Recommended Actions*, Massachusetts Institute of Technology, 2004, p 28.

7.4.1 European lighting-related product

Firstly, exterior lighting with artificial lights provides a more convenient visibility and safety to European citizens, for example with more illumination and intensity, and adaptability for European industrial and commercial development. In spite of these advantages, various effects on the dark-sky environment, nocturnal ecological systems, energy wastage, and annoyance to human being raises significant concerns about outdoor lighting activities at night. To promote environmentally friendly light sources or illuminating engineering products, EU institutions, agencies and bodies have to set a range of legal aspects considering necessary or proportionate standards of light sources as an important part of European light pollution control. The effectiveness and efficiency of light products need to be standardised and certified in order to safeguard an environmentally friendly use of lighting products, which can be attained by conducting outdoor lighting practices at European level. Some perceptions about sustainable performance of light products and light pollution concerns are referred to by some implications of EU secondary sources of law and their guideline approaches for understanding European standards of light products, including their European light pollution concerns by the EU efforts to mitigate some aspects of light pollution through current economic incentives as well as existing legal instruments. For example, The *EU Directive 2009/125/EC of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products* or the *Energy-related Product Directive 2009* (ErP Directive) magnificently aims to reduce a number of environmental impacts of energy-related products, including the energy consumption throughout their entire life cycle. These European requirements have much significant potential for being improved in order to reduce impacts and to achieve energy savings through better design which also leads to economic savings for businesses and end-users, including lighting using products and lighting-related products. [447] Because of the subjective electricity element of many light-using products and lighting-related products, they are

[447] Malcolm, R., 'Analysis: Ecodesign Laws and the Environmental Impact of our Consumption of Products', *Journal of Environmental Law* 2011 23 (3), pp 487-503. and see Malcolm, R., ' Integrated product policy: products and their impact on energy', *International Journal of Law in the Built Environment*, 2011 3(1), 48–64.

energy-related products which are devices that produce artificial light by the flow of electric current though public or private systems of electrically powered lighting. The ErP Directive also provides two significant approaches to reducing the energy consumed by European market-based instruments: European certified labelling to inform specific energy saving characteristics of light products and European energy efficiency requirements for light product design.[448] Nevertheless, it will be argued that when these EU regulations are applied to European single market, there is still the inadequacy of action so that the standards of light sources require by EU law may be too low for ordinary consumers, thereby disclosing the information and knowledge which the average consumer needs, according to the light pollution context to take an informed commercial decision as well as their own light pollution prevention. This means that EU law has not established a duty of disclosure when light pollution from energy-related products is an adverse effect of the European single market[449] and other potentially harmful impacts of light pollution are expressed by EU concerns about whether essential information of light pollution-related products should be given by manufacturers, traders and retailers.

7.4.2 European lighting practices

Secondly, light products are things likely to be used for personal, household, commercial or industrial production and consumption. The EU institutions, agencies and bodies by regulatory approaches require the use, and prescribe the energy-related form and content, of energy efficiency labels which contain the information as mentioned above. They have made significant progress in terms of quality of lighting-related products, which are subject to a consumer product safety rule under the ErP Directive. However, it does not contain a reference to light product safety practices or a voluntary light pollution reduction standard, unless such light product conforms to the Member States' compulsory lighting requirements of such domestic lighting practice

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[448] Cheyne, I., 'Proportionality, Proximity and Environmental Labelling in WTO Law', *Journal of International Economic Law*, 2009 12 (4), pp 927-252.

[449] Swan, E. J., 'UK energy trading regulation: The EMP regime', *Journal of Financial Regulation & Compliance*, 2002 10 (2), pp 168–176.

standards, for example, full cut-off luminaires, low-reflectance surfaces, a phased ban on the sale of incandescent bulbs and low-angle spotlights. This research, in particular, argued in detail that whilst the EU law is generally considered to be another part of the legal context which carries on energy efficiency standards and industrial lighting requirements as mentioned above, there is no single regulatory framework for harmonising and increasing environmentally friendly light use and practice at European level. These limitations of EU law involve many obstructions and difficulties being placed in the way of lighting-related product users seeking to exercise their right to know how their outdoor lights eco-friendly operates, for example by requiring manufacturers, distributors, and retailers to give information about when they have been implicated in the light pollution from their light products which caused Europe's light pollution problems in the future. In other words, a regulatory approach will be needed to lead to the European steps needed in order to achieve regional or trans-boundary light pollution control by creating a duty to disclose light pollution information and sustainable lighting practices, as discussed in more detail in Chapter 8 and 9.

7.4.3 European planning development control

Thirdly, planning development and construction in European urban landscapes generally provide various benefits associated with a wide range of outdoor activities and a sense of human well-being. The installation and design of urban outdoor lights also have a significant role to play in supporting the urban development and planning challenges in Europe. However, excessive or obtrusive urban outdoor lights at night have been increasingly indicated as a contributing factor[450] to European light pollution.[451] If unplanned expansion of urban lighting facilities threatens both intrinsically dark landscapes and high district brightness areas, as it dramatically creates environmental, social and economic impacts for both the cities and countryside of

[450] For example, atmospheric smog caused by the scattering of urban lights into the sky, particularly from outdoor lighting in urban brightness areas. See Institution of Lighting Engineers, *Brightness of illuminated advertisements TR05*, 3rd edition, Institution of Lighting Engineers, 2001, pp 1-2.

[451] Illuminating Engineering Society of North America, *IESNA Technical memorandum addressing obtrusive light (urban sky glow and light trespass) in conjunctions with roadway lighting, Illuminating Engineering Society of North America Technical Manual TM-10-00*, Illuminating Engineering Society of North America, 2000, pp 1-9.

Europe[452], the improvement of the overall dark-sky quality of urban areas would be addressed by EU institutions, agencies and bodies. Even though the *European Landscape Convention 2000* (the Florence Convention) as a key primary source of the EU planning law[453] established an efficient and effective planning development procedure and provided the sustainable use and participatory development of land in Europe[454], secondary sources of EU planning law have not successfully provided specific actions to conserve and maintain the significant or characteristic features of dark-sky landscape or environmentally friendly lighting landscape in Europe.[455] This means that specific legal measures of light pollution prevention, such as environmental or dark-sky zoning for outdoor lighting control within European or trans-boundary planning development in Europe, would be excluded.[456] Nevertheless, the Florence Convention can help address general environmental concerns, which are that EU planning and land use frameworks might harmoniously integrate Member States to make specific measures dealing with unnecessary or inappropriate planning development of outdoor light premises or facilities in European urban areas, particularly where there is a lack of scientific evidence or planning knowledge to enable Member States to reform their domestic planning and land use law in the near future.

7.4.4 European green building standards

Fourthly, light pollution has an environmental or human effect of the illuminating engineering practices and architectural lighting design as referred to in Chapter 2. Intrusive or obtrusive lighting in the wrong place at the wrong time is a side effect of inappropriate or unnecessary use of outdoor lights. A number of environmental, economic and social benefits, contributing enormously to the visibility and convenience

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[452] European Commission/Joint Research Centre, *Urban sprawl in Europe: The ignored challenge EEA Report No 10/2006*, European Commission & European Environment Agency, 2006, p 41.

[453] Finch, J., '"What more were the pastures of Leicester to me?" Hunting, Landscape Character, and the Politics of Place', *International Journal of Cultural Property* (2007) 14 (3), pp 361–383.

[454] Council of Europe, *European Landscape Convention Florence, 20.X.2000: Explanatory Report*, Council of Europe, 2000, pp 1-7.

[455] Barral, V., 'Sustainable Development in International Law: Nature and Operation of an Evaluative Legal Norm', *European Journal of International Law*, 2012 23 (2), pp 377-400.

[456] Bauer, A. A., 'Council of Europe Framework Convention on the Value of Cultural Heritage for Society', *International Journal of Cultural Property*, 2007 14 (1), pp 431–440.

of European citizens who lives in European urban areas are provided by outdoor light premises and exterior lighting facilities at night. While the aims of international or domestic green building law are to ensure a range of performance standards for certifying the environmentally friendly premises through international or national rating system, the key EU green building law, such as the *Energy Performance of Buildings Directive (Directive 2010/31/EU) on sales and rental prices indicating that better energy efficiency*[457] is rewarded in the market, does not carry out any European commitments to specific light pollution control objectives for incorporating all mixed solutions[458] of illuminating engineering technologies and architectural lighting design. There is no specific provision for minimising light pollution from green construction or premises because of the lack of European soft and hard legal actions in this particular area.[459]

7.4.5 Enforceable or measurable metrics of European light pollution

Next, as referred to above, this research considers what necessary or appropriate indicators should be taken to deal with obtrusive light limitations for European outdoor lighting fixtures and environmental zones for outdoor lighting control within European planning development strategy, alongside the question of whether and how enforceable

[457] Heijden, J., 'Regulating sustainable construction in Europe', *International Journal of Law in the Built Environment*, 2013 5(1), pp 5–19.

[458] Illuminating engineering bodies and architectural environmental bodies may work based on practical cooperation of their joint non-legal binding instruments for good lighting practices. If professional people (i.e. registered professional engineers and architects) engaged in the professional lighting practices of building, the professional authorities in Member States could define the scope of each branch of professional illuminating engineering and architectural lighting design other than general engineering or ordinary design for which registration is provided under the Member States' codes of professional lighting conduct for engineers and architects.

[459] Many international green building standards, however, established the minimum level of energy efficiency for the proposed building and systems to reduce key elements of light pollution, such as sky glow, glare, and light intrusiveness associated with excessive or obtrusive lights. For example, the Leadership in Energy and Environmental Design (LEED) of the U.S. Green Building Council as global green building criteria gives a property an energy efficiency rating certification if building owners or tenants can attempt to carry out adequately mitigating and reducing of urban light pollution from outdoor premises and facilities through LEED rating system. See U.S. Green Building Council, *LEED 2009 for New Construction and Major Renovations Rating System*, U.S. Green Building Council, 2008, pp 19-20. and Banani, R. A., *A sustainable assessment method for non-residential buildings in Saudi Arabia: Development of Criteria*, School of Construction Management and Engineering Transfer Report, Ph.D, University of Reading, 2011, p 15.

or measurable metrics of European light pollution should be adopted by the EU. The EU has several regulatory functions and processes. Where it has identified environmental or astronomical risks through environmental zoning for outdoor lighting control within European urban planning development strategy, as well as obtrusive light limitations for outdoor lighting fixtures, it will be able to offer an enforceable measurable metric as a measurable light pollution indicator to European policy makers, with responses in relation to measurements of the outdoor light pollution – not only for policy makers, but also the regulators, and other relevant stakeholders such as manufacturers, producers, service providers, suppliers, wholesalers, distributors and retailers. Therefore, several metrics of measurement of light pollution in the SI Units with special names and symbols (i.e., luminous intensity (cd), illuminance (lux), and luminous flux (lm)) may provide a number of environmental indicators of acceptable or unacceptable degrees of outdoor light, which measure light pollution with greater clarity as to appropriate and inappropriate lighting practice, and engender better sustainable lighting practice across EU Member States.[460] When the EU requires all Member States to evaluate all intrinsically dark landscapes and district brightness areas that are at risk from non-environmentally friendly or inappropriate outdoor lights, it may carry out its own consultation on a number of questions, both general and specific, such as details of how to harmonise the quantification of light pollution level.[461] It may set preliminary harmonised standards at a level sufficient to protect human health and the night environment with an appropriate marginality of sustainability, energy efficiency, safety and security for all European population targets, without regard to non-health impacts such as cost.

7.4.6 Fragmented elements of European measures for light pollution control

Finally, there are several possible grounds for laying down various rules on European legal elements for environmentally friendly lighting practices. Member States may have

[460] National Institute of Standards and Technology, *The United States and the Metric System*, available from http://www.nist.gov/pml/wmd/metric/upload/1136a.pdf accessed 3 June 2014.

[461] WHO European Centre for Environment and Health, *Burden of disease from environmental noise Quantification of healthy life years lost in Europe*, available from http://www.euro.who.int/__data/assets/pdf_file/0008/136466/e94888.pdf accessed 3 June 2014.

considerable powers to adopt and implement these elements of European regulatory frameworks. Implementation of several European elements is committed, and Member States should adopt proportionately and necessarily in responding to precautionary or preventive approaches of all legal aspects of light pollution control. However, gaps, fragments or loopholes of the majority of existing EU legislation have not been merged into a single directive on light pollution control, which applies to all main impacts of European light pollution (sky glow, glare and light intrusiveness), for the entire EU region requiring Member States to approach harmonisation and integration of the European light pollution control in a single European regime whereby Member States will undertake a certain stage process, to identify light pollution problems.[462]

7.5 A comparative approach to EU law regarding light pollution

This research critically proposes that generally a number of gaps, fragments and loopholes of the EU law should follow European energy, environmental and planning approaches of the comparative perspectives. Where this European legal issue is not addressed satisfactorily, reforming the EU law on sustainable lighting practices in light of the EU energy, environmental and planning provisions could help establish greater harmonisation and integration of standards that could set up to undertake new perspectives for light pollution prevention in Europe.

Imbalance between outdoor lighting and dark-sky preservation whereby a single EU framework is required to consider the European light pollution problem could be reformed to include European enforceable measures as well as alternative measures.

[462] For example, if the EU institutions, agencies, bodies and Member States purpose to integrate identification of their intrinsic dark-sky landscapes and district brightness areas in Europe that are potentially vulnerable to unnecessary or non-environmentally friendly lighting, and where efforts to map European preliminary light pollution zoning should be focused, they would have to apply in line with the integrated all pillars of environmental zones for outdoor lighting control within their dark-sky preservation and ecological habitats protection. In other words, to ensure that the environmental zones for outdoor lighting control are undertaken with full regard to necessary or proportionate environmental measures identified in stage process of the European joint dark-sky and nocturnal ecological prevention established in the EU law, the exercise of the EU law to undertake relevant existing measures to control environmental zones for outdoor lighting control, such as the Habitats Directive (92/43/EEC) and the Birds Directive (2009/147/EC), could be set out in planning control actions that deliver objectives in the relevant European potential environmental, energy and human health benefits.

Even though there are differences in law governing outdoor lighting between Member States' regulatory frameworks, as is illustrated by the domestic legal systems and national energy, environmental and planning regimes in Member States, partial or fully harmonised measures for light pollution control aim to harmonise all concepts of light pollution law by establishing necessary or proportionate provisions with overarching principles of the EU energy, environmental and planning law. This can lead to a sustainable balance between rights to use outdoor lights, rights to a healthy environment and rights to peaceful enjoyment of dark-sky heritage. Therefore, this subheading raises academic questions as to the importance of such European comparative perspectives and their ongoing EU law comparison. They would give the EU institutions, agencies and bodies more certainty in how they respond to European light pollution problems, by providing a single law which may bring environmental and socio-economic benefits, as mentioned above.

A question arising in this European light pollution context[463] is whether, in connection

[463] This research therefore recommended that the legal definition of light pollution should be established by way of an appropriate extension of the light pollution contexts to apply European environmental and planning frameworks as appropriate and to include other European lighting requirements to apply the environmental and planning measures by European intuitional instruments and other relevant incentives to new developments as they arise. In the same way, the EU has been built through a series of binding regional environmental laws, and EU Member States have sought to harmonise EU environmental laws and adopt common measures on an increasing number of environmental issues. Likewise, to develop an EU standard that provides environmental solutions for compliance with a legal provision, the EU should make a single framework for the improved control of light pollution arising from regional industrialisation as well as commercialisation; nevertheless the EU does not set out the requirements for assessment and control of light pollution. The current EU Directives have not required Member States to assess if night environment is at risk from excessive or obtrusive light that is allowed to illuminate or pollute areas not intended to be lit. In the future, the EU should set out the lighting requirements for all forms of light pollution that aims to limit the amount of light that can be used and minimise all forms of light pollution, for example, glare, sky glow and light intrusion. The lighting requirements under EU legislation may become a significant instrument to determine which luminaires are appropriate for each landscapes as well as areas. It may be necessary to establish a single definition of light pollution in the future. Thus, light pollution under the future EU laws should be probably described as "*excessive or obtrusive light in the wrong place at the wrong time, have the potential to cause and damage to European dark-sky heritage and the European night environment, including the nocturnal ecological systems and the climate change contribute to an increase in peripheral usage of unnecessary light pollution in Europe*". This definition of light pollution may usefully support and affect the substantive rules of existing EU legislation setting out the environmental and planning provisions to be observed for the purpose of protecting public interests such as health, safety, energy and protection of the night environment.

with process-related technical requirements and standard-setting in relation to existing European thresholds[464], the problems of European law reform, which can frequently be observed when dealing with non-environmentally friendly lighting, can be better solved.

While some Member States have adopted their national and local measures designed to limit light pollution from outdoor light premises and facilities, EU law has not enabled EU institutions, agencies, and bodies to adopt legal aspects that need to be considered before risks and harms of European light pollution occur if no special official measures are taken. As a result of a series of legal concerns, the comparative approaches of the existing regulatory frameworks in Europe can potentially help to more systematically clarify alternatives of exploring and examining legal principles in different contexts. According to the functionalism of the existing light pollution law in Europe, comparative legal approaches will help understand different nations' laws as solutions to similar light pollution problems.[465] If EU institutions, agencies, and bodies do not consider analysing and learning from its light pollution experiences in the use of legal instruments for controlling common or joint international or trans-boundary light pollution problems[466], introducing comparative law for applying various principles of EU energy, environmental and planning law in the face of scientific uncertainty of illuminating engineering technologies or architectural lighting innovations will be an important possibility that could potentially harmonise and integrate the joint stage process of light pollution in Europe.

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[464] Winter, G., 'Standard-setting in Environmental Law', in Winter, G. (eds), *European Environmental Law: A Comparative Perspective*, Dartmouth Publishing, 1996, pp 109-128.

[465] Whytock, C. A., 'Legal Origins, Functionalism, and the Future of Comparative Law', *Brigham Young University Law Review*, 2009 6 (13), pp 1879-1906.

[466] However, there are immense possibilities for the comparison of different regulatory light pollution means of meeting the comparative law challenges set by the common goals and joint principles in EU law, and how they are implemented and enforced within the different legal contexts by the Member State, for example, urban settlements, economy, infrastructure, education, culture, and demographics. See Darpo, J. and Nilsson, A., 'On the Comparison of Environmental Law', *Journal of Court Innovation*, 2010 3 (1), pp 315-336. and also see Henderson, D. F., 'Comparative Law in Perspective', *Pacific Rim Law & Policy Journal*, 1992 1 (1), pp 1-9.

7.6 The use of comparative law analysis in EU light pollution law reform

Meanwhile, the EU law not only means that individual problems of each Member State are integrally resolved, but also that international or trans-boundary environmental harms in Europe may be commonly concerned. Light pollution has been identified by the *EU Parliamentary Assembly Resolution 1776 (2010) on Noise and Light Pollution* as among the preliminary areas of common light pollution problems requiring joint actions as well as shared stage processes. Linkage of European light pollution problems and cooperation among the various countries can contribute to awareness of the common light pollution problems faced by Member States in both the European region and European sub-region in their tangible development for light pollution control.

Comparative light pollution law is a narrow comparison, a specific approach that compares two or more Member States' regulatory frameworks to discover the similarities and differences of the Member States' regulatory frameworks for outdoor lighting practices between the domestic legal measures and to study various comparative approaches to EU law regarding light pollution. Comparative legal studies can be performed on common or joint problems of European light pollution to obtain perspectives on EU law reform.

In Chapter 8, much of the comparative analysis is based on a critical review carried out of various light pollution laws throughout international jurisdiction and European Member State's jurisdictions. Chapter 8 discusses a number of Member States' regulatory frameworks, contains a comparison with various measures and include a comparison with incentives of the EU single market regime. Additionally, European light pollution law reform must be examined by the comparative method. This identifies particular areas where European light pollution has to be mitigated and prevented by joint stage processes and working together with EU institutions, agencies, bodies, Member States, stakeholders and citizens.

Chapter 8: Light Pollution Law in Different Countries

The main purpose of this Chapter is to analyse the law on light pollution control and to improve national or municipal light pollution regulatory frameworks by filling in the existing gaps of current regulatory frameworks and providing better sustainable prevention of light pollution. We propose to do so by examining a single set of necessary or proportional regulatory standards to combat light pollution at both a national and local level. Our review of the jurisdictions and the legal systems available for both light pollution control and sustainable lighting practices has highlighted the recent evidence of such influence of hard and soft law on legislation in different countries.[467] When comparative law on different jurisdictions is discussed, the influence of a comparative approach in each national or municipal light pollution law is, at most, one of finding inspiration in the procedure of proceeding the summarises our proposals for reforming[468] national or municipal law of light pollution control in favour a specific solution.[469]

This research cited the eight example jurisdictions[470] where they have identified light pollution harms and adopted legislation designed to control outdoor light pollution from

[467] Various selected countries, such as Slovenia, Japan, Italy, Spain, Chile, France, Canada, and the United States treat outdoor light pollution and other matters of non-environmentally friendly light for the most elements in very similar terms. The major similarities relate to outdoor lighting standards. They have several distinctive measures and England has not yet applied to its legal system.

[468] Smits, J. S., 'Comparative Law and its Influence on National Legal Systems', in Reimann, M. and Zimmermann, R. (eds), *The Oxford Handbook of Comparative Law*, Oxford University Press, 2006, pp 477-512.

[469] This could be seen as a benefit for the whole pictures of the common standard for regulatory light pollution control, but it would be particular benefit in relation to comparative law studies. Returning to the example of countries where there are specific light pollution provisions to be found in the example jurisdictions, it may be recently questioned why the English light pollution law should be similar to that in the example jurisdictions according to whether the English light pollution legislation would be better to be developed in terms of further options for light pollution law reform.

[470] Much of this light pollution law literature concerns English language as a medium of research degree instruction. The use of the English language to research comparative light pollution law subjects in English jurisdiction where the first language of the majority of the population is English. These overall analyses are based on different foreign documents, but they are all in English version. Some of the positive effects of English-medium light pollution research that they are able to accommodate English and foreign people, relevant light pollution law texts and material are available in English, legislatures and policy makers across the world have a competitive advantage in the reform of national light pollution law and are prepared for an academic world dominated by English. See Rogier, D., *The effects of English-medium instruction on language proficiency of students enrolled in higher education in the UAE*, Doctor of Education in TESOL Thesis, The University of Exeter, 2012, p 33.

non-environmentally friendly fixtures and inappropriate design. For example, some example jurisdictions choose to make rules to address environmental risks of outdoor light pollution or the use of the appropriate mechanism for setting illuminating areas, illumination levels, shielding requirements, and illuminated light curfews. Citing these, the example legislation included in this comparative law research contains detailed foreign light pollution frameworks covering all aspects of key philosophy, mechanisms, instruments, and metrics of light pollution control, demonstrating how these examples, set out in this Chapter, will apply to English light pollution control rules made to follow significant standards from the eight example jurisdiction which relate to that national or municipal control, and allowing the English light pollution control to be further strengthened through comparative law approaches.

Additionally, the comparative analysis of non-environmentally friendly lighting also requires consideration of many legal factors, including the measured or calculated/predicted level of outdoor light at night, described in regulatory terms of an appropriate light metric.[471] The regulatory metrics from example jurisdictions may retain a dependency on the night environment in which it was measured to predict the light pollution emitted by the sources of non-environmentally friendly outdoor light. These regulatory metrics are related to measurable criteria for people and nocturnal life to assess foreseeable effects.[472] Indeed it makes sense to compare light pollution law in one country with light pollution law in another country. As such, in the foreign country, light pollution law encompasses not only the rules governing a metric more closely associated with negative health effects than other general light metrics[473], but also the

[471] World Health Organization, *Burden of disease from environmental noise Quantification of healthy life years lost in Europe*, Regional Office for Europe of the World Health Organization & JRC European commission, 2011, p 5.

[472] Bailey, H., Senior, B., Simmons, D., Rusin, J., Picken, G. and Thompson, P. M.,'Assessing underwater noise levels during pile-driving at an offshore wind farm and its potential effects on marine mammals', 2010 (60) *Marine Pollution Bulletin*, available from http://www.abdn.ac.uk/lighthouse/documents/Bailey_Assessing_underwater_2010_MPB.pdf accessed 30 June 2014.

[473] The parameters of light pollution will enable appropriate legal actions, required to be determined, based on a consideration of non-environmentally friendly levels of outdoor light, the number of people potentially affected and the annoyance response to the sources of outdoor light at night. See Transportation Working Group, *Environmental Noise Directive Action Plan*, available from

consequences of scientific understanding of environmentally friendly level of light, whereas in England these rules governing all parameters of light pollution are not to be found within the English legal system.[474]

8.1 Background and Contexts

The growth of district brightness areas in many countries has increased the number of outdoor premises and facilities because various outdoor lights have been rapidly sprawled. Where a right to dark-sky quality and a right to a healthy environment have been lost, either because of lighting obtrusiveness or because the lighting excessiveness have been rapidly sprawled, it is clear that lighting emissions, as a result of man-made activity, can be harmful to human health or quality of the environment. This has led to a corresponding increase in key elements of light pollution, i.e. sky glow, glare, and intrusiveness, which either demonstrate a failure of some State authorities to comply with natures in relation to the balance of day and night or show a lack of respect for fundamental principles of the environmental law.

While environmental pollution problems are generally addressed more effectively and efficiently through different legal systems[475], light pollution is a significant problem that demands and deserves the attention of legal mechanisms such as planning orders, in respect of outdoor lighting premises, management of environmental nuisances from outdoor lighting, a ban on non-environmentally friendly illuminated premises and other

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http://www.scottishnoisemapping.org/downloads/NAPS/Transportation_NAP_Revised_Dec_2010.pdf accessed 30 June 2014.

[474] Pieters, D., *Functions of comparative law and practical methodology of comparing or how the goal determines the road!*, available from https://www.law.kuleuven.be/personal/mstorme/Functions%20of%20comparative%20law%20and%20practical%20methodology%20of%20comparing.pdf accessed 30 June 2014.

[475] At the same time, national and municipal light pollution problems can often be addressed through the legal system. The fundamental effect of regulatory light pollution control is to prohibit the artificial light that is illuminating areas or landscapes not intended to be lit without the State authority's consent at national level. On the other hand, regulatory control of international or trans-boundary light pollution shares transnational objects, with the additional purposes of respecting state sovereignty and preserving relations between countries at international level. See Hall, N. D., 'Trans-boundary Pollution: Harmonizing International and Domestic Law', *University of Michigan Journal of Law Reform*, 2007 40 (4), 681-746. and See further Handl, G., 'Territorial Sovereignty and the Problem of Transnational Pollution', *The American Journal of International Law*, 1975 1 (69), pp 50-76.

relevant lighting practices.

The functioning of legal systems fundamentally depends upon various functional characteristics[476] of inherited systems of the law, if necessary with the reforming and applying of their legal matters and elements from legal systems' backgrounds. In particular, the role of main legal systems in the development of pollution control legislation by requiring statutory or written law approaches of pollution control measures relies on enforceable State mechanisms in order to provide enforceable pollution control standards with the indispensability and proportion to minimise the level of pollution. However, despite different legal backgrounds in legal systems, there are two similar conditions for the control of outdoor light pollution: the disputes of neighbourhood parties concerning excessive levels of lights or intrusive direction of lights and the conflict between urban light growth and environmental protection. It may be noted that the main legal systems of the world, such as the common law system[477], civil law system[478] and other systems[479] may be able to influence a State's legislative decision-making, or the State may bring important environmental justice to intervene in

[476] Michaels, R., 'The Functional Method of Comparative Law', in Reimann., M. and Zimmermann, R. (eds) *The Oxford Handbook of Comparative Law*, Oxford University Press, 2006, pp 339-382.

[477] Environmental duty to prevent pollution (such as air pollution, noise pollution, water pollution, soil pollution, thermal pollution, radiation pollution and light pollution) can be explained by reference to the written national constitutions (i.e. the U.S. Constitution and the Australian Constitution) under the Federal common law system. On the other hand, theoretically what the general environmental duty has done is to widen the statutory law's concept of neighbour to include the environment under the English common law system. This marks a fundamental difference between the Federal common law and the English common law. See McGrath, C., *Does environmental law work?: How to evaluate the effectiveness of an environmental legal system*, Lambert Academic Publishing, 2010, p 69.

[478] Civil law system is the dominant legal tradition today in most of Europe, all of Central and South America, parts of Asia and Africa, and even some discrete areas of the common law world (e.g., Louisiana and Quebec which inherited two legal systems: civil law from French legal system and common law from English legal system). Many regulatory frameworks from civil law jurisdictions include necessary key elements of light pollution that most of existing provisions of light pollution control be merged into the national regulatory frameworks. See Apple, J. G. and Deyling, R. P., *A Primer on the Civil-Law System*, available from http://www.fjc.gov/public/pdf.nsf/lookup/CivilLaw.pdf/$file/CivilLaw.pdf accessed 30 June 2014.

[479] For example, China has been developing the socialist legal system which involves a range of legal aspects of the traditional Chinese law and the modern western law. See Underwood, J., A Brief Introduction to the Legal System of China, available from http://faculty.cua.edu/fischer/comparativelaw2002/bauer/china-main.htm accessed 30 June 2014. and see further Goelz, D. J., 'China's Environmental Problems: Is A Specialised Court the Solution?', *Pacific Rim Law & Policy Journal*, 2009 1 (18), pp 155-187.

various concerns of light pollution, even if it does not have specific regulatory provisions under the relevant existing legal frameworks.

As mentioned above, statutory or written laws (for example, from planning law established in support of environmental zoning for exterior lighting control within national planning regimes) that responds nationally to light pollution control also helps to deliver a range of legally binding obligations. Enforcing hard law in the functioning of outdoor lighting control helps protect the environment when levels of outdoor light reach an unhealthy range. In particular, artificial light that is allowed to illuminate or intrude upon areas not intended to be lit is considered to be a statutory nuisance in legal systems.

Jurisdictions not only have the choice on how to establish a number of hard laws for light pollution control, but also sometimes request that professional bodies for outdoor lighting practices look at how best to practice outdoor lighting through non-legally binding rules[480] of professional bodies. They generally establish the practical lighting requirements to develop, under their own authority, outdoor lighting standards for professional lighting fixtures and design. While soft law (e.g. non-legally binding rules of illuminating engineering bodies or the architectural lighting bodies) may not apply less stringent standards than those stated in hard law (e.g. legally binding rules of the national environmental pollution control law), a number of mixed approaches[481] for addressing professional lighting standards from both hard law and soft law may be used to create threats to compliance with key aspects of light pollution.

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[480] Morgan-Taylor, M., Light Pollution, *Nuisance and Planning Laws in the UK: The Legal Methods of Controlling Light Pollution in the UK*, SHB2012 - 8th International Symposium on Sustainable Healthy Buildings, Seoul, Korea. 19 September 2012, pp 257-302.

[481] For example, the U.S. Green Building Council (USGBC) provides some guidance to landlords and tenants in the field of professional green building design in keeping with the aims of the U.S. professional engineering and architectural bodies and promotes the light pollution control in modern construction as well as new refurbishment. It is intended to promote both legally and non-legally requirements through compliance of the U.S. Better Buildings Act of 2014 and the U.S. Green Building Council's Leadership in Energy & Environmental Design Green Associate Study Guide. See U.S. Green Building Council, *LEED 2009 for New Construction and Major Renovations*, available from https://f2.washington.edu/cpo/sites/default/files/file/cpoutlook/LEED%20Green%20Associate%20Study%20Guide.pdf accessed 30 June 2014.

Furthermore, case law on conflicts of lights or disputes involving lighting, plays an important role in the jurisprudence of the civil law systems and the common law systems, particularly in relation to proceedings for judicial precedents which have risen dramatically since artificial lighting technology was invented and developed. Even though light is essential for outdoor activities, excessive or obtrusive outdoor artificial lights have the potential to increase various negative effects that artificial light has on human health and the environment, as mentioned in Chapter 2. The courts of justice in some jurisdictions have played a significant role by developing case law on light pollution, despite the fact that many legal systems merely include a few relevant provisions. The courts rule precedential principles of light nuisance by setting legal lighting standards and giving legal lighting precedents to the society, which will be taken into consideration during law covers on light pollution when any lighting practices that are prejudicial to health or a nuisance unreasonably interfere with the use or enjoyment of a neighbour's premises under light nuisance provisions of the law and act as a precedential standard to the Government, environmental governing bodies, local authorities and ordinary outdoor light users.

As mentioned above, the legal context of light pollution control law has resulted from more recent light pollution situations. Concern for the quality of dark-sky and night environment in urban areas has resulted in national and municipal laws, followed significantly by national environmental, energy and planning frameworks. Although it is difficult to measure the influence of light pollution control law and regulations on legal systems, there are many qualitative elements that influence lighting governance at both national and local levels, each of which produces effects that interact with those of others, which makes interpreting the impact of legal context of environmental light pollution more complex.

The legal contexts of light pollution control law also involve the quantitative illuminating engineering assessment of environmental lighting justice, as mention in Chapter 2. Lighting governing bodies have tended to agree with the uses of measurable

metrics[482] of the International System of Units (SI) for outdoor light pollution emittance measurement in principle, but have questioned how these metrics would work in practice and what measurable approaches for light pollution evaluation there would be.[483] Some have raised issues of light pollution measurements in relation to the potential impact on human health and the night environment.[484]

This research can see, in urban areas where light pollution can be worse, that there may be circumstances[485] where as it may be necessary to set metrics for light pollution control. Firstly, emissions of sky glow represent the majority of all released direct upward light in urban areas.[486] Secondly, emissions to atmosphere are most likely to result in the imbalance of the 24-hour day/night ecosystem cycle.[487] Therefore, the degree of outdoor light may be evaluated to quantify light pollution. The identification of the level of the upward light ratio of the installation (flux), vertical illuminance (lux), light intensity (Cd), luminance (Cd/m2) and curfew illuminance (lux) identified as the

[482] Legislators, policy makers and other relevant stakeholders usually find several levels of outdoor light experienced to be acceptable and unacceptable. The standard for outdoor lighting practices generally states that intrinsically dark areas and district brightness areas with light emission level of less than unacceptable level are acceptable for public human health and the night environment. Nonetheless various individuals may have a calibrated visual eye and broadly know the range of outdoor brightness levels which light emit when operating in the vicinity of their outdoor landscapes and premises. See Department of Transport and Regional Services, *Expanding Ways to Describe and Assess Aircraft Noise*, Department of Transport and Regional Services, 2000, p 18.

[483] Deru, M., Blair,N. and Torcellini, P., *Procedure to Measure Indoor Lighting Energy Performance*, National Renewable Energy Laboratory, 2005, p 1.

[484] An important consideration for outdoor lighting areas is the impact that any outdoor light is going to have on the night environment. Light pollution into surrounding outdoor areas must be reduced to an acceptable minimum level. See Welsh Rugby Union, *Facilities Guidance Note 8 Floodlighting*, available from http://www.wru.co.uk/downloads/Floodlighting.pdf accessed 30 June 2014.

[485] However, official environmental authorities may need to be used with precaution and prevention when comparing several patterns of outdoor light emission between different district brightness areas and in these circumstances the measurable SI Unit metric is a more useful tool. For example, sensitive landscapes, such as conservation areas, can be especially prone to light pollution impacts on human health and the night environment. There are a range of metrics through which light pollution can be measured, principally through the awareness of planning authorities for new urban lighting development proposals and by highway authorities in designing and managing highway/street lighting. See Hertfordshire County Council, *Light pollution and conservation areas*, Hertfordshire County Council, 2002, pp 1-7.

[486] International Dark-Sky Association, *Estimating the Level of Sky Glow Due to Cities*, available from http://www.darksky.org/assets/documents/is011.pdf accessed 30 June 2015.

[487] Wu, B. and Wong, H., *Visualization and Analysis of Light Pollution: A Case Study in Hong Kong*, ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Volume I-2, 2012XXII ISPRS Congress, 25 August – 01 September 2012, pp 171 – 176.

degree of outdoor light pollution[488] may be a straightforward highlighting of comparative areas of locally significant environment risk that exist for each illuminating landscape, along with clear evidence that people are exposed to outdoor levels considered unsafe. Each measurement of outdoor light pollution level is able to provide a consistent level overview of the potential risk of outdoor lights at night from local sources of light pollutants, such as street lights, security lights, commercial lights, sports light facilities and domestic decorative lighting. Therefore, the measurable metrics of outdoor light pollution can provide the vehicle for local authorities and light industrial stakeholders to develop a shared understanding of light pollution levels, including setting out priorities for action, maintenance needs and links into regulatory light standards. However, in terms of illuminating engineering practices in relation to environmental protection metrics, again this may be seen in environmental protection criteria to equate with a potential measurement of outdoor light pollution as it could be. Other set of light pollution measurements in the future may include new aspects of light pollution control, where those who are meant to be regulated, control a set of regulatory measurement, and metrics that, for example, suggest that the existing technologies in modern LED lighting sometimes provide flashing or flickering at frequencies that may induce a biological human response (i.e., outdoor flickering light from outdoor electronic billboards and signs is a variation of the optical output of a light source and may have health effects in terms of headaches, migraine and dizziness[489]) which should be regulated by a few specific metrics for considering environmental light standard when trying to mitigate unintentional biological effects of outdoor flashing or flickering lights.[490]

Environmental governing bodies and local authorities have responsibility for

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[488] U.S. Department of the Interior National Park Service, *Polarized light pollution: Alternative hypotheses and resource management concerns*, U.S. Department of the Interior National Park Service, 2010, pp 1-3.

[489] Jägerbrand, A. K., 'New Framework of Sustainable Indicators for Outdoor LED (Light Emitting Diodes) Lighting and SSL (Solid State Lighting)', 2015 (7) *Sustainability*, available from http://www.mdpi.com/2071-1050/7/1/1028 accessed 30 June 2015.

[490] Wilkins, A., Veitch, J. and Lehman, B., *LED Lighting Flicker and Potential Health Concerns: IEEE Standard PAR1789 Update*, available from http://www.essex.ac.uk/psychology/overlays/2010-195.pdf accessed 30 June 2015.

environmental pollution control, but lack some measurable metrics to put this into a mandatory measurement of outdoor light pollution. Many national Governments, however, have no clear compulsory responsibility for dealing with environmental zones for planning light pollution control. This means all necessary specific metrics have not been set to manage light pollution levels and alternative metrics for illuminating engineering may not help in adapting locally to some adverse impacts of excessive or obtrusive light on outdoor light pollution, but may also need to be set differently. Additionally, the legal philosophy of the environmental zoning for outdoor lighting control in foreign hard and soft laws only establishes allowable levels of outdoor light pollution or requiring permits for potentially harmful lighting emission, but it seems illuminating engineering metrics of outdoor light pollution may not always be available to justify the commitment of outlining how urban sprawl contributes to outdoor light pollution, how use of new illuminating engineering technology endangers human health, and how to consider the risk to protected people when deciding planning applications.

The use of a metric evaluating light pollution measurement is welcomed by soft law and hard law in some foreign jurisdictions. However, it could be argued that the relationship between SI unit metrics, some specific light pollution incidents and other light pollution control rules were at issue in inadequate metrics and measurement methods because the regulator and policy makers could not apply modern illuminating engineering metrics for outdoor light pollution control in such a way as to quantify all key elements of light pollution. The metrics for the light pollution degree indicator may be calculated based on several degrees of non-environmentally or inappropriate light pollution. For example, a modern Outdoor Site (lighting) Performance (OSP)[491], as an alternative

[491] Outdoor Site-Lighting Performance (OSP) is a modern measurable technique designed to help outdoor lighting installers limit light leaving their necessary lighting landscape, while providing the flexibility to meet environmental protection needs. The OSP will allow the outdoor lighting installers to compare the performance of the lighting system relative to other, similar outdoor lighting landscapes. It uses a measurable box surrounding an outdoor lighting installation to predict light leaving the site which may become intrusive light shining on other properties. See Rensselaer Polytechnic Institute, *OSP Methodology – Glow and Trespass*, available from http://www.lrc.rpi.edu/researchAreas/pdf/instructions_for_building_OSP_box.pdf accessed 30 June 2015. and See also Crayk, S., *How effective is the utilisation of increased street lighting as a situational crime*

comprehensive system for addressing degrees of artificial light intrusiveness[492], seems to offer a more flexible approach in which the illuminating engineering bodies and light professional bodies are informally committed to a particular way of standardisation of outdoor lighting measurement (e.g. light pollution metrics are specified), but only to alternative objective (e.g. light pollution metrics must be alternatively used as a basis for non-legally binding outdoor site rating system). Although there are many alternative metrics of outdoor light use linked to light pollution control as to referred above, the use of modern illuminating engineering strategies, by offering a number of resources and incentives, has not been promoted by the environmental governing bodies and local authorities and a number of alternative metrics have not been put in the necessary measures to enable people to reduce the degrees of non-environmentally friendly light emissions they produce.

The regulatory measurement of upward light ratio of an installation (flux), vertical illuminance (lux), light intensity (Cd), luminance (Cd/m2) and curfew illuminance (lux) to identify the degree of outdoor light pollution remains a key driver of light pollution recovery and sky glow resolution. Where necessary, for reasons of human health, visual safety, and the night environment, the metrics could have features to help prevent people from key elements of light pollution.[493] One does not, however, require an especially sophisticated regulatory view to conclude that these metrics remain a far from perfect anti-light pollution measurement when people need confidence that necessary or appropriate metrics of the light pollution rules could be set in order to solve key elements of light pollution without environmental hazards and health effects and to reconsider the balance between the level of light quality pollutant emissions and the outdoor night-time activities. For example, concerning measurable metric provisions on the dark-sky conservation zones, the regulatory metrics should take account of the expected level of outdoor light at night when setting up the respective dark-sky

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prevention method?: Applying social, environmental and economic costs and benefits, Community Justice Portal, 2012, p 18.

[492] Rensselaer Polytechnic Institute, *Belleayre Resort: Assessment of Proposed Outdoor Lighting*, Rensselaer Polytechnic Institute, 2011, p 12.

[493] Cohan, D., *Sidelighting Photocontrols Field Study: Scoping Study for Daylight Metrics from Luminance Maps*, Northwest Energy Efficiency Alliance, 2006, pp 4-5.

conservation areas for astronomical observatory vision. On the other hand, these metrics are said to be illegible if they do not measure in ways that allow observatory astronomers to easily visually observe where they need to be safe from dangerous native animals at night, when an expectation of both astronomical observation and life safety at night has the same importance in the same area at the same time.

The regulatory metrics for light pollution measurement and control have currently passed into foreign laws, as mentioned below, marking a key milestone in controlling key elements of light pollution by improving light fixtures, increasing energy efficient design and maintaining the appropriate level of outdoor light pollution in intrinsically dark landscapes, as well as district brightness areas. With the introductory contexts of the regulatory metrics in foreign laws raising of outdoor lighting standards, the question of ensuring quality of outdoor life and activities becomes a more significant regulatory concern.

Although there has been an effort to identify regulatory metrics of non-environmentally friendly lighting measurement in foreign soft and hard laws, it seems that they have not yet introduced a new legal obligation requiring the legislator and policy makers to apply a new quantification of non-environmentally friendly illumination from various outdoor light sources. The application of modern metrics may follow new effectiveness of preventive or precautionary approaches for lighting standardisation in exceptional circumstances where there is an explicit environmental or energy efficient mandate. This research also focuses instead on whether legislators and policy makers understand the circumstances in which the modern metrics of regulatory measurement come into critical question, and whether modern measurable metrics are taken to address risks on human health and the night environment.

For excessive or obtrusive light as a pollutant, two additional characteristics of light are relevant, these being direction and spectrum. Light pollution, the harmful direction of outdoor light in the night environment, comes from glare, sky glow as well as light intrusiveness, but questions remain about why legislators and policy makers have not decided to invoke the regulatory measurement of wavelength and what measurable

effect this will have on human health and the environment.

A selection of parameters of unacceptable wavelength may be an important key.[494] But questions still remain. Regulators and policy makers may not consider whether evidence of failure of legal standards calls into critical question wavelength pollutants[495] to meet the environmental lighting requirements of the legal standards because they have been looking at ways to reduce energy cost by using LED efficient lights at night, although LED technology itself emits a higher proportion of potentially dangerous blue wavelength light.[496] At the root of both the economic value for energy saving standards and the failure of evaluating regulatory wavelength metric systems lie conflicts of energy efficient and environmental interest. The illuminating engineering techniques of quantifying acceptable metrics for wavelength pollutants may be used to estimate the legal metrics with respect to the level of environmentally friendly or acceptable light wavelength.

In the future, regulators in both foreign and English jurisdictions may have regard to economic cost[497] of the health impact of harmful light wavelength when considering any metrics for outdoor light fixtures and will seek to balance the interests of all stakeholders when discussing the topic of harmful light wavelength from a health perspective, reflecting the best available evidence from a health, energy, economics and

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[494] Muthu, S., Schuurmans, F. J. P., Pashley, M. D., 'Red, Green, and Blue LEDs for White Light Illumination', *IEEE Journal on Selected Topics in Quantum Electronics*, 2002 8 (2), pp 333-338.

[495] David, A., and Krames, M. R., *Whiteness enhancement by LED sources*, available from http://test.scripts.psu.edu/users/m/u/muw157/papers/%5B2013%5D%20--David%20et%20al--%20Whiteness%20enhancement%20by%20LED%20sources.pdf accessed 30 June 2015.

[496] Nelson, J. A. and Bugbee, B., *Economic Analysis of Greenhouse Lighting: Light Emitting Diodes vs. High Intensity Discharge Fixtures*, available from http://cpl.usu.edu/files/publications/publication/pub_8264567.pdf accessed 30 June 2015.

[497] Legislators and policy makers may critically explore effective solutions to the problem of urban district brightness landscapes, and the mechanism of atmospheric sky glow compensation may be considered to be a relatively effective approach. The design and implementation of such a compensation mechanism is a very complicated economic incentive, however, which beneficially involves not only the defining of environmental and dark-sky responsibilities, but also comprehensively includes ecological pollution compensation and economic pollution compensation. A main initiative in nationalising the costs of national light pollution, and calls for the environmental or dark-sky assessment of national economic losses in advance may be useful. See Zhang, X. L., 'Assessing the Economic Costs of Water Pollution in the Yangtze River, China', 2014 (1) *Journal of Ocean and Coastal Economics*, available from http://cbe.miis.edu/cgi/viewcontent.cgi?article=1005&context=joce accessed 30 June 2015.

policy angle and identifiing future regulatory metrics for an outdoor light pollution standard. The remaining subheadings consider a number of foreign light pollution laws and legal problems that will be debated when deciding upon which comparative law has an important role to play in the field of light pollution law reform.

Thus, if no single part of the legal system or level of authorities regulates all environmentally friendly lighting metrics and light pollution control activities, this Chapter will need to conduct detailed comparative law studies to discover whether there is a possibility of a regulatory development and, if so, the linkages of a legal context which create significant legal measures as well as specific regulatory measurements. The legal systems in different jurisdictions are becoming involved in same key context of light pollution and similar environmental disputes, concerning intrusiveness of outdoor lighting (e.g. there should be full consideration of shared light pollution problems and there should be a similar approach within various juridical authorities by making legal awareness of the non-environmentally friendly lighting and how to avoid it at both national and local levels.).

Whether or not all light pollution harm to the environment exists will depend on the results of scientific studies, the existence and nature of any linkages of light pollution, and the conduct of the professional lighting bodies. But environmental science alone cannot answer the question of whether or not all practicable steps to avoid light pollution harm to the environment are significant. The critical question of what is significant is a matter of regulatory reform, based on comparative law studies taking account of all relevant evidence, which reviews the role of legal measures in legal systems, significantly focusing on how comparative law comes to be regarded as an aspect to fill gaps in existing laws.

8.2 Concepts of light pollution control under law – lessons from civil law countries and common law countries

While the world has inherited fundamentally and substantively different legal systems, this research examines the shared need for common criteria of light pollution law between different legal systems and major concepts of such regulatory light pollution

control in the present day world. In addition to fragmentation of international and European light pollution laws regulating environmentally friendly lighting as mentioned in Chapter 6 and 7, various aspects of light pollution in any jurisdiction also means that it is difficult for State Governments to identify the risk of a significant effect on the basis of non-environmentally friendly outdoor lighting.

Where there is a need to impose any legal measures dealing with light pollution this might be done through the common law system and the civil law system, either by the use of light pollution control standards under national laws or through measures under local laws. Alternatively, if non-environmentally friendly outdoor lighting is a causing specific disturbance to astronomical landscapes or ecological areas, a number of technical approaches to the potential problems related to astronomical or ecological prevention, of which light pollution control is one part of special environmental issues (i.e. legal prospective on the problem of light pollution at sea turtle nesting beaches), can be recognised by local or municipal authorities when purpose is the protection of the night environment considered to be of special value in terms of specific light pollutants, which have to be under threat.

There might be many other positive or negative factors from legal systems, which influence the effectiveness of such regulatory techniques and legal methods to produce their positive effects of light pollution control. However, some might argue that the best method for choosing necessary metrics and appropriate legal measures is that the provisions should meet a balance between lighting energy consumption and environmental protection at national level. This part is to distinguish a number of legal aspects of the light pollution laws into many concepts covering: (i) considering comparative linkages between light pollution control and legal systems; (ii) separating the key examples of light pollution control laws; (iii) clarifying the comparative light pollution laws (comparative study of law for light pollution control purposes).

8.2.1 Considering comparative linkages between light pollution control and legal systems

The concepts and principles of light pollution control that are coherent with the energy,

environmental and planning laws have played a significant role of domineering all matters of regulatory techniques and legal methods to produce a number of positive effects of environmentally friendly lighting and appropriate light use at both national and local level. The common law system and civil law system are rooted in the world legal system, with inherited development since then from, mostly law sources. It is, therefore, necessary to analyse the different principles from both dominant legal systems to consider which are of particular relevance to legal aspects of light pollution control law; almost the all kinds of key aspects are of relevance to light pollution control. The relationship between light pollution control laws and legal systems should be the subject of a critical discussion about the best way in which each jurisdiction could face the legal problems posed by the legal system into national or local light pollution control laws.

8.2.1.1 The influence of common law system on the light pollution laws

The common law system, meaning the procedural rules that are established by judges through the decisions in the cases they have heard[498], tends to be case-centred and hence judge-centred, allowing scope for a precedential discretionary, *ad hoc*, pragmatic approach to the particular problems that appear before the court of justice.[499] In a common law system, case law in relation to light pollution is generally created by a court of justice's previous precedents set after judges decide light pollution cases. This would provide an opportunity for the common law (the *ius commune*) not only to improve the precedents on retention beyond a reasonable time, but also to clarify and make more intelligible the precedential rules on light pollution control through conclusive evidence of light pollution harms regarding possible threats to human health and the environment. In addition, the common law system also adopts a number of statutory laws affecting a wide range of environmental impacts of artificial light on individuals and the public. Many written statutory rules, passed by law-making institutes[500], have adopted legal concepts of light pollution control designed to limit

[498] Open University, *Judges and the law: Common law, equity and statute law*, available from http://labspace.open.ac.uk/mod/resource/view.php?id=415866 accessed 10 July 2014.
[499] Slapper, G. & Kelly, D., *The English Legal System*, 14th edition, Routledge, 2013, p 5.
[500] Partington, M., *Introduction to the English Legal System*, Oxford University Press, 2011, pp 36-37.

harmful effects of non-environmentally friendly lighting and inappropriate light use.

There are essentially two main examples of the significant influence of the common law system on light pollution laws introducing a wide range of measures to tackle light pollution: English common law[501], and U.S. common law[502]. Obvious examples in the English legal system and U.S. legal system where law-making institutes have responded to light pollution matters by making legal instruments in many regulatory forms of light pollution control are procedural rules and substantive law, both of which are greatly influenced by the previous court decisions and legal frameworks.

Firstly, in the English legal system, the previous common law nuisance regime lacks a coherent light pollution framework (prior to the statutory light nuisance regime coming into enforce), and it merely provides a few examples of case law[503] relating to a specific interpretation of some forms of a neighbour's annoying lights or intrusive lights where legal aspects of artificial light nuisance have been made by the English courts in their successive judgements.[504] At present, light pollution has been currently extended by new English Statutory Nuisance provisions of the Environmental Protection Act 1990 under the Clean Neighbourhoods and Environment Act 2005, which involves artificial light emitted from outdoor lighting premises. It has been defined as any form of artificial light that is prejudicial to health or a nuisance and is emitted from or caused by intrusive lights as well as spill lights.[505] However, these provisions do not cover all

[501] Stringham, E. P. & Zywicki, T. J. 'Common Law and Economic Efficiency', in Parisi, F. & Posner, R. (eds) *Encyclopaedia of Law and Economics*, George Mason University School of Law, 2010, pp 1-43.

[502] Tidmarsh, J. & Murray, B. J., 'A Theory of Federal Common Law', *Northwestern University Law Review*, 2006 2 (100), pp 589 - 654.

[503] See *Bonwick v Brighton & Hove District Council* (2000) BN 906721 where the English court held that all major causes of obtrusive light from outdoor security lighting premises should be switched off. This case was the first case in English law to recognise outdoor light as a potential source of artificial light nuisance.

[504] See *Stone Haven and District Angling Association v Stonehaven Recreation Ground Trustees* [1997] 60 SPEL 36, January 1997 where the English Court held that artificial light from sports club disturbing the river's ecological systems affecting the human night-time activities.

[505] After the English statutory nuisance instrument has been made, the law gives English people the ability to take independent action under Section 82 of the Environmental Protection Act 1990 by contacting the Magistrates' Court if a source of outdoor light if proved to be prejudicial to health or a nuisance. For example, in *Broxbourne Borough Council, R (on the application of) v North and East Hertfordshire Magistrates' Court (Defendant) and Oliver G (Interested Party)* [2009] EWHC 695

aspects of light pollution although some forms of light pollution might affect the aesthetic beauty of the dark-sky environment and interfere with astronomical observation. While such critical arguments have been theoretically interesting in discussions of all the aspects of environmentally friendly lighting or sustainable light uses, as mentioned in previous Chapters, the comparative law analysis, as mentioned in following Chapters, will be motivated in part by the increasing benefits in the reform of English statutory nuisance and other English statute laws through comparative legal analysis.

Secondly, in U.S. common law, various types of light pollution can be designated as a common law nuisance if there are a number of factors to be taken into the courts' consideration when determining if a light source is causing a common law nuisance and is affecting the right of a landowner or occupier to the use and enjoyment of property. Despite a fundamental distinction between the independent actions of trespass and nuisance being the difference in the legal right protected under legal aspects of U.S. common law, the U.S. plaintiffs complaining about intrusiveness of light reached the U.S. courts by bringing a claim against a neighbouring individual or entity in one of two ways[506]: light as a legal nuisance or light as a technical illuminating engineering trespass. Although a plaintiff party who makes a legal claim must prove the facts for that light intrusiveness claim[507], a concept of the risk of light intrusiveness seems to be inseparable from U.S. common law system wherein issues of light pollution fact are decided on any rational basis by human beings.[508] While the philosophy of traditional

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(Admin) it was held that the Magistrates' decisions on both the abatement notice and the costs order were subsequently quashed. See further Department for Environment, Food and Rural Affairs, *An Investigation into Artificial Light Nuisance Complaints and Associated Guidance*, Department for Environment, Food and Rural Affairs, 2010, p 13.

[506] See *Shelburne v Crossan* 122 A- 749 [1923] and *Hansen v. Independent School Dist.* No. 1, 61 Idaho 109, 98 P.2d 959 [1939] where the U.S. courts held that excessive or obtrusive lights can previously be designated light nuisance under the U.S. common law if it is proved to be prejudicial to health or a nuisance. See Temple Group, *Assessment of the Problem of Light Pollution from Security and Decorative Light Published Guidance/Standards on Obtrusive Light: A report by Temple (assisted by NEP Lighting Consultancy) to the Department for Environment, Food and Rural Affairs*, Temple Group, 2006, p 10.

[507] Wexler, S. and Efforn, J., *Burden of Proof and Cause of Action*, available from http://lawjournal.mcgill.ca/userfiles/other/8625856-wexler.pdf accessed 10 July 2014.

[508] James, F., 'Burdens of Proof', 1961 (51) *Virginia Law Review*, available from http://digitalcommons.law.yale.edu/cgi/viewcontent.cgi?article=4121&context=fss_papers accessed 10

U.S. common law may be insufficient for environmental policy makers to make public light pollution interest decisions (based on an abundance of caution or furtherance of other public sky glow control purposes), it has not been proven yet via the illuminating engineering methods and therefore cannot - or at least should not - provide the basis for non-environmentally friendly lighting metrics of excessive or obtrusive lighting in a legal case.[509] Therefore, the U.S. Court found that in light pollution cases the interference with a person's right to health could be justified by the individual interest of human health and wellbeing. It deals with artificial light nuisances that are under a burden of proof consideration or are of individual health interest. If emission of artificial light with negative appraisal occurs repeatedly, this can affect individual well being, i.e. sleep disorders and other health problems.

However, to make artificial light pollution control, some U.S. States and municipalities have proposed establishing the duty of public light pollution control. It is for both people and their municipal authorities, and not only the individual, to prove that the matter must either be an intrusive light nuisance in its own right or be prejudicial to public interest health, in order to set regulatory measurable metrics of light pollution. This is a fair balance between public and private environmental interests because the justification of environmental light pollution will be carried with both general artificial light nuisance and regulatory measurable metrics of light pollution.

At present, in U.S. conflicts of environmental and dark-sky interest, the U.S. light pollution provisions were set up under the municipal legislative frameworks to adopt necessary measures designed to limit light pollution from excessiveness and obtrusiveness of outdoor lights. In practice this means that the U.S. municipal legislative frameworks in several states[510], not only cover general requirements of

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July 2014.

[509] Harlow, B. E. and Spencer, R. W., *An Inconvenient Burden of Proof? CO2 Nuisance Plaintiffs Will Face Challenges In Meeting the DAUBERT Standard*, 2011 (32) *Energy Law Journal*, available from http://felj.org/sites/default/files/docs/elj322/13-459-daubert.pdf accessed 10 July 2014.

[510] The International Dark-Sky Association (IDA) currently worked with the Illuminating Engineering Society of North America (IESNA) to develop the Model Lighting Ordinance (MLO) for municipal adoption in the U.S. jurisdiction. This U.S. model law has been expanded to include several broader legal aspects of sustainable lighting practices. The aim of this model law is to promote the general dark-sky

public light pollution control, but also provide lighting requirements for housing outdoor lighting in order to decrease light nuisance conflict between neighbours where a light nuisance is any regular intrusiveness or obtrusiveness that prevents a neighbour enjoying their home.

Notwithstanding the growing importance of the harmful light pollution and the suitable lighting practices which comprise it, it is clear now what, legal aspects if any, the English common law and the U.S. common law have, if intrusiveness of light occurs when unwanted light from outdoor premises enters a neighbour's surrounding property, for instance, by shining over a neighbour's private area. Written rules of light pollution control in both English and U.S. common law jurisdictions are made by the national and municipal governments. These are known as legal instruments (i.e. English statutory nuisance and U.S. States' municipal frameworks), which are published and are subject to a degree of light pollution control, and they normally apply throughout their common law jurisdictions. So, the common law systems of England and the U.S. jurisdictions have taken a series of written sources of light pollution laws through developments of former case law and previous legal responses where the legislation at the time had not settled the problem of intrusiveness of light.

Although English common law is a source of inspiration for various common law jurisdictions when developing its case laws and statutory nuisances, in the absence of some legal aspects of light pollution control, the enforcement of current English laws can provide little or no formal link to the increasingly effective counter-measures to control all aspects of most Commonwealth Nation members' light pollution.

The common law system is intended to regulate and control use of outdoor lighting through unique common law methodology and a series of legal forces. If English

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preservation and good lighting practices by providing for the necessary and appropriate use of outdoor light facilities, outdoor light premises, billboard lights, light technological features, and areas within the U.S. municipal jurisdictions that reflect special elements of the U.S. local areas' outdoor lights for the light pollution control reasons. On the other hand, in English jurisdiction, there is no a model law which designed to assist the U.K. Government and its all tier system of local government in reforming and modernizing their national and local laws on dark-sky and environmental protection so as to take into account the special legal features and needs of legal responsibility to consider light pollution problems.

common law and U.S. common law wish to limit unnecessary or inappropriate lights, it may refer to their current legal instruments in the critical analysis given above.

8.2.1.2 The influence of the civil law system on the light pollution laws

The civil law system, or *Romano-Germanic* legal system, is the legal system of many countries or other territorial jurisdictions of states or providences of a federation with various written private and public laws, significantly based or influenced by ancient Roman legislation (the *ius civile*).[511] While civil law jurisdictions are based on concepts, theories, and rules derived from ancient Roman law, with a strong influence of written law traditions, it is very important to look at new legal aspects of light pollution control when starting up the uses of modern illuminating engineering technology and light design techniques.

There is no existence of electrical lights throughout the Roman Empire in Roman times[512], but a modern series of electric lights was invented during the 19th century by Thomas Alva Edison and light scientists. This means that there are no specific legal theories of light pollution control, which are applied consistently across the Roman Empire[513] by ancient Roman frameworks. However, the civil legal system makes extensive use of written laws (i.e. codes and statutes), which are generally designed to cover all protective factors where modern scientific assessment has shown a continuing

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[511] Zaphiriou, G. A., 'Introduction to Civil Law Systems', in Danner, R. A. & Bernal, M. H. (eds) *Introduction to Foreign Legal Systems*, Oceana Publications Inc., pp 47-56.

[512] However, ancient artificial light was common throughout the Roman Empire, and pottery oil lamps offered an alternative to candle light. It could have had an important effect on the ancient lifestyle of those who did acquire it. See Craven Museum & Gallery, *Roman Pottery Lamps*, available from http://www.cravenmuseum.org/archaeology/fact-sheets/roman-pottery-lamps/ accessed 10 July 2014. and see also Suffolk County Council, *Economy, Skills and Environment Roman lantern from Glemsford*, available from http://www.suffolk.gov.uk/assets/suffolk.gov.uk/Libraries%20and%20Culture/Archaeology/2011-10-27_GlemsfordLantern.pdf accessed 10 July 2014.

[513] Roman people can enjoy being able to view the natural night-time skies when dark skies in Roman era are areas that are relatively free from light pollution at night. However, where practices and other factors of outdoor lighting are poor in a period beginning in the last quarter of the 20th century when outdoor lights become necessary for people from civil law countries, people cannot enjoy being able to view the night skies and enjoy the healthy environment. So, written laws which are influenced by legal aspects of the civil legal system should contain a right to a healthy and ecologically balanced the night environment and the duty to preserve dark-sky heritage.

need for environmental precaution and protection.

Parliaments, authorities, municipalities or local authorities in civil law jurisdictions generally create written light pollution laws referred to as a hierarchical system of law in different forms of written laws, for example, national written constitutions, written acts of national parliaments, and a variety forms of written delegated laws. As a result, light pollution laws are not created equally, but the civil legal system usually influences a hierarchy of light pollution laws based on the particular geographical contexts and the requirements of primary legislation from which the sources of light pollution laws are derived. The hierarchical system of law is common practice in different civil law jurisdictions and can benefit jurisdictions for outdoor lighting control within national and local planning regimes. While regional and local light pollution controls tend to be much more specialised than national pollution control, it is important to give an overview of how the national authorities enforce the written light pollution legislation, for which they have responsibility, through the use of a central standard of national light pollution.

The civil legal system is one of the most successful contemporary legal systems of the world in history. It is the most widespread legal system that has brought significant benefits to the contemporary operation of light pollution control. It shows all the characteristics of written legislative approaches to promote light pollution control activities, giving a high degree of environmental protection. When there is uncertainty as to the future of illuminating engineering development and light pollution harms, the recent crisis of light pollution problems has demonstrated the benefits of codifying light pollution law in many national jurisdictions in many local areas. Examples include the French national laws relating to light pollution prevention in the *French Ministry of Ecology, Sustainable Development and Energy Order of 25 January 2013 concerning the lighting of non-residential buildings at night in order to limit light pollution and energy consumption* as well as the *French Environmental Code Article L583-1* (*Code de l'environnement Article L583-1*), which were originally French civil law. Accordingly, the civil legal system was supposed to overcome all contemporary light pollution problems by introducing a traditional way of codifying legal aspects, which

represented a turning point in the method of regulation by written light pollution law.[514]

Most of the written light pollution laws have been incorporated by civil law jurisdictions through other influences of astronomical and environmental aspects, and the uniqueness of the civil legal system has played a significant role in the success of formal regulatory control, to the benefit of dark-sky preservation and night environment protection in which civil law operates in each jurisdiction, and, where it is possible, the range of certain precautionary and preventive practices that could operate in each civil law jurisdiction. Nonetheless, there is, of course, the preliminary question of how civil law would even have practical influence over considering law reforms in some common law, and in particular in considering them on the foundation of statutory laws. These are explored in the next subheadings.

8.2.1.3 A mix of distinctive influence of common and civil law systems on light pollution laws

In some national jurisdictions, environmental protection legislation guarantees that everyone has the right to a healthy environment when enjoying the night sky, living with natural day/night cycle under pluralistic legal systems.[515] These jurisdictions cover a situation in which common law and civil law coexist in one geographic location and/or population.[516] For example, Louisiana is a unique jurisdiction in the U.S. where the French and Spanish codification based system is used and it is also influenced by the existence of the U.S. jurisdiction based Federal common law system. While some common law and civil law countries have been responsible for adverse impacts of light pollution through their legal activities, there is no direct link between pluralistic systems and the effective control of light pollution through the relationship with its benefits and

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[514] Canale, D., 'The Many Facts of the Codification of Law in Modern Continental Europe', in Canale, D., Grossi, P., and Hofmann, H. (eds) *A Treatise of Legal Philosophy and General Jurisprudence: Vol. 9: A History of the Philosophy of Law in the Civil Law World, 1600-1900*, Springer, 2009, p 138.

[515] Orucu, E., 'What is a Mixed Legal System: Exclusion or Expansion?' in Orucu, E. (eds) *JCL Studies in Comparative Law No. 2: Mixed Legal Systems at New Frontiers*, Wildy, Simmonds & Hill Publishing, 2010, pp 53-77.

[516] Michaels, R., 'Global Legal Pluralism', 2009 (5) *Annual Review of Law and Social Science*, available from http://scholarship.law.duke.edu/cgi/viewcontent.cgi?article=2679&context=faculty_scholarship accessed 28 August 2014.

advantages of legal pluralism. Furthermore, there are no specific legal controls in various mixed common and civil law jurisdictions, although light pollution can have adverse effects on both human health and the environment.

The main legal systems of the world, common law and civil law, generally provide a number of different advantages as mentioned above, but there is the critical question of what legal systems are the most appropriate to light pollution control. Whilst both of these legal systems have occasionally offered dominant legal advantages in different terms of light pollution control, they nonetheless fail to mention something in their unique methodology. For example, the common law system generally relies on court precedent in formal adjudications. The case law related to light pollution is considered to be binding precedent of former courts' decisions. On the other hand various aspects of illuminating engineering technology and architectural lighting deign does not necessarily rely on former illumination technology and new environmental harms can be developed by new forms of outdoor lighting. This means that the court in common law jurisdiction might fail to seek the necessary precautionary or preventive approach to up-to-date environmental challenges of new light pollution problems in decisions of the court.

In contrast with common law tradition, regulatory light pollution frameworks in the civil law system are necessarily codified or written by regulators or law-makers and they might be more easily updated by amending or repealing the light pollution provisions through reforms of the existing law. If codified light pollution law or written light pollution law under the civil legal system succeeds in becoming more practicable and applicable to apply than common law, the codification of written light pollution provisions might spread widely.[517] Moreover, a series of law reforms to the authorities carrying out necessary or proportionate functions can be designed to support the growth of urban lighting and to shape preventive approaches to new harmful illuminating engineering technology, as well as non-environmentally friendly lighting design. The reforms of the codified or written law will clarify the regulatory frameworks where their

[517] Scarman, L. G., 'Codification and Judge-Made Law: A Problem of Coexistence' *Indiana Law Journal* 1967 3 (42), pp 355-368.

provisions are confusing, or written in modernising legal methods to ensure that light pollution law keeps pace with technological developments. Notwithstanding, given the formal written enactment to light pollution control, and, in particular, the role of a modern common law system in streamlining statutory light nuisance for some forms of light pollution over others, one could argue that common law should be conceptualised as statutory law rather than case law.

This brings within enhancing a range of considerations relevant to a number of differences from state-based legal systems.[518] Written law influences both common law and civil law systems where it is reasonably clear that light pollution would need to be addressed through clarifying measures reflected in the written styles[519], as introduced above. It will become a great instrument for light pollution prevention, both of which are important in influencing and trending environmental and planning laws within the legal regimes.

8.2.1.3 Strengths and weaknesses of common and civil law systems on the light pollution laws

To highlight some of the conceptual differences between common legal system and civil legal system, and to explore the possibilities of reconciling of some of those light pollution control differences[520], there will be differences in how each legal system operates, and its light pollution control metrics and its mechanisms.[521] As referred to above, common law (i.e., a procedural rule that is established by common law judges through the decisions in the cases they have heard) is not the only way of minimising glare and light spilling onto adjoining properties, and common law jurisdictions (i.e., England and U.S. State jurisdictions, have adopted a statutory mechanism for setting

[518] Frank, J. N., 'Civil Law Influences on the Common Law – Some Reflections on "Comparative" and "Contrastive" Law', *University of Pennsylvania Law Review*, 1956 7 (104), pp 887 - 926.

[519] The convergence of common law and civil law jurisdictions might be shaped by similarity of light pollution problems and trans-national light pollution laws. See Markesinis, B. S., *Foreign Law and Comparative Methodology: a Subject and a Thesis*, Hart Publishing, 1997, pp 191-193.

[520] Pejovic, C., 'civil law and common law: two different paths leading to the same goal', *Victoria University of Wellington Law Review*, 2010 2 (23), pp 817-842.

[521] O'Connor, V., *Practitioner's Guide Common Law and Civil Law Traditions*, International Network to Promote the Rule of Law, 2012, p 3.

illuminating areas, illumination levels, shielding requirements, and illuminated light curfews. However, a weakness of common law case precedent is an adjudged case or decision of a court, is considered as furnishing an example or authority for a similar light pollution case arising afterwards or a similar question of lighting practice problems. This means judges' precedents of the common law are used as tool for following the results of previous precedents, rather than as tool for achieving modern pollution management. In other words, it seems that common law courts precedentially set the characteristics of light disturbance, which artificial light emitted from outdoor light premises so as to be prejudicial to human health or a nuisance have been taken into account. The degree of light falling where it is not wanted has been involved in determining some types of light pollution emissions, such as light intrusiveness and light spillage. On the other hand, common law courts have not delivered their precedential judgment in many light pollution areas and not yet upheld the public awareness about the actual effects of urban growth and thereby alleviated sky glow concerns. So, common law courts miss out landmark sky glow that is still a key contributor to outdoor light pollution, shining into urban areas and into the atmosphere, causing the orange smog that hangs over public areas that can affect people's quality of lift and the night environment.

While the development of the illuminating engineering technology has achieved considerable success in reducing light pollution through light shielding fixtures as well as energy efficiency design, the common law courts have never ruled a metric, based on the number of outdoor light events that local authorities, light industries and light practitioners must take action to ensure light pollution is reduced when outdoor light disturbs a person's daily life and produces public sky glow. This is arguably the weakest point in the common law system and this is leading to questions over whether common law precedents are not being used to their full potential, although light pollution metrics are useful when considering how atmospheric light or sky glow is shared around a local population. However, a number of written forms of hard and soft laws in common law systems explore the measurable metrics of excessive or obtrusive light in order to illuminate suitable degrees of outdoor lighting. For example, written frameworks (i.e,

soft law and hard law) from illuminating engineering bodies and State's municipalities committed to ensuring that their outdoor lighting standards have the appropriate metrics and suitable degrees to take light pollution control action in support of outdoor light practitioners and are therefore taking forward the International System of Units (SI) of illuminance and luminous emittance. Regarding these views about the strengths of soft law in common law as alternatives[522], it generally sets out the non-compulsory metrics of outdoor light pollution that environmental governing bodies, local authorities, other relevant light practitioners will alternatively consider when practicing their light fixtures and design.

On the other hand, hard law (in contrast to soft law) in both common and civil legal systems generally refers to legally binding frameworks that are mandatorily enforceable by the Government and local authorises. A range of degree and metrics exists to prohibit unlawful emission of outdoor light pollution and protect the rights of neighbours in various areas including human health and the night environment. So, all light stakeholders have legal obligations under hard law not to emit outdoor light pollution. They have mandatory obligations under light pollution legislation in hard law. The hard law in both common and civil law systems may provide a single legal framework and a more streamlined law that is meant to be more effective at tackling some key elements of outdoor light pollutants and setting measurable metrics of outdoor light. Once soft law and hard law have been agreed by light practitioners, there should be careful consideration of any special request for an exception to be made for any installation on the grounds of festival, history, safety or security condition, as mentioned below.

Of course, we will also continue to analyse and evaluate widely using both common and civil legal systems, but all jurisdictions based on their common or civil legal systems have their strengths and weaknesses. As mentioned in the following subheadings, the

[522] Shaffer, G. C. and Pollack, M. A., 'Hard vs. Soft Law: Alternatives, Complements, and Antagonists in International Governance', 2010 (94) *Minnesota Law Review*, available from http://www.minnesotalawreview.org/wp-content/uploads/2011/08/ShafferPollack_MLR.pdf accessed 28 August 2014.

key examples of light pollution control laws with pending instruments, mechanisms, degrees and metrics have enacted light pollution rules as best practice. Every context of the light pollution laws from main example jurisdictions could describe the key elements of light pollution control that will always guide law reform choices, and could define what constitutes success for enhancing strengths and reform weaknesses through appropriate outdoor light standards in England.

8.2.1.4 Advantages and disadvantages of hard and soft law in both common and civil legal systems

The desire of outdoor light pollution control is to tackle the harmfulness of all key elements of obtrusive lighting activities spilling over into another to the detriment of human health and the night environment, but the risk is that the ability of legislators or regulators to find suitable legal solutions to future light pollution problems would be undermined. The failure to adequately reduce light pollution to tolerable levels for more people has seen attempts to expand obtrusive light limitations for outdoor lighting fixtures fail.

While other pollution laws (i.e., water pollution, air pollution, soil pollution, noise pollution, water thermal pollution, and electromagnetic radiation pollution) regulate the metrics, control and enforcement of impacts of environmental activities; for example, setting allowable levels of pollution or requiring permits for potentially harmful activities,[523] light pollution law is a set of lighting governing rules, which is a system of complex and interlocking statutes, common law, treaties, conventions, regulations and policies which seek to protect human health and the night environment which may be affected, impacted or endangered by outdoor lighting activities.

Whenever this research particularly considers outdoor light to be so excessive, so intrusive, so repeated, of such duration or pitch or occurring at such times that it gives

[523] United Nations Environment Programme, *Environmental law and Multilateral Agreements*, available from http://www.unep.org/training/programmes/Instructor%20Version/Part_2/Activities/Interest_Groups/Decision-Making/Core/Environmental_Law_Definitions_rev2.pdf accessed 28 August 2014.

people reasonable cause for environmental degradation, as mention in Chapter 2[524], the light pollution law in many foreign jurisdictions and legal systems generally includes, but is not limited to, traditional categories such as night environment protection, nocturnal species conservation, pollution, cultural dark-sky heritage, light pollution impact assessment, and planning and development laws.[525] However, degrees of law maintained by many governments, environmental authorities, lighting governing bodies, astronomical governing bodies and other relevant bodies also contain controls on key elements of outdoor light pollution in some circumstances.

In principle, this research can classify two main types of light pollution law under a different classification for different legally binding or enforceable degrees that may control light pollution.

First, hard light pollution law is a set of legally binding rules, which are issued by the governments or municipalities with the approval of the official lighting governing bodies. It outlines a number of requirements for protection of the night environment in the conduct of outdoor lighting practices. Its guidelines also require that the Government and local authorities weigh the public interest of those outdoor lighting activities against the public interest in the protection of people health and the night environment. National or municipal jurisdictions may adopt hard law designed to limit light pollution from sources of non-environmentally friendly or unnecessary light. Second, soft light pollution law is a set of non-legally binding rules, which are issued by the government, municipalities, professional lighting bodies, or professional astronomical bodies. It particularly creates a range of guidelines that are not legislative instruments and that are therefore not legally binding, but it is based on a set of light pollution control standards, which professional lighting bodies and professional astronomical bodies developed, in liaison with the other lighting industry stakeholders.

Similarly both hard and soft light pollution laws are a range of written technical terms

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[524] Department of the Environment, Community and Local Government, *A Guide to the Noise Regulations*, Department of the Environment, Community and Local Government, 2004, pp 1-4.

[525] McGrath, C., *Does environmental law work?: How to evaluate the effectiveness of an environmental legal system*, Lambert Academic Publishing, 2010, pp 37-38.

given to outdoor lighting standard requirements that set the minimum standards or conditions which apply, for example, the minimum amount of lighting needed for its specific purpose, the eco-friendly direction of lights, the SI Unit metrics of outdoor brightness measurement, the energy efficiency sources of outdoor light, and the urban planning zoning for outdoor lighting control. Despite the similar roles set out above hard and soft light pollution law in various jurisdictions are markedly different in both regulatory degrees of environmental protection and enforceable undertakings of light pollution control.

While some key example jurisdictions of this research as mention below have adopted hard light pollution designed to limit light pollution from outdoor lights and other relevant installations, hard laws have both advantages and disadvantages. The key advantage is that the legally binding rules of hard light pollution law are a regulatory term given to legally binding requirements in regulations that establish the minimum standards which apply. The obligations of hard law generally consist of the legally binding conditions together with technical lighting requirements specified by the government or municipalities in guidance to people, light industry stakeholders and the relevant light practitioners with which are compulsory or mandatory conditions. In other words, the key disadvantage is that the greater flexibility in their environmental approaches to light pollution control is not provided sometimes and hard law may not be reflected in other environmental and planning legislation.

On the other hand, soft law would usefully provide all light stakeholders and the relevant light practitioners with more flexibility to reduce light pollution because it is only an important option to achieve light pollution control and in accepting soft light pollution law they may agree to abide fully or partially by the terms of the soft law framework, which may include non-mandatory or non-compulsory measures for controlling light pollution. The key disadvantage is that soft law lacks some of the features of enforcement and compliance because the legally binding commitment to reduce light pollution emission is not represented by soft law.

While both soft and hard laws present numerous challenges, they still offer similar

benefits to people and light practitioners in the areas of light pollution control and environmental awareness. It is particularly easy to apply both soft and hard law contexts, because they have similarly evolved to deal with outdoor lighting practices. If national or municipal governments set both soft and hard laws in their jurisdictions, as well as legal systems, people and light practitioners can follow the substance of the context of light pollution control in both soft and hard laws by implementing all aspects of compulsory and alternative light pollution control. However, this research also raised two issues where further mixed use of hard and soft laws may be required: mixed legally binding and non-legally binding approaches for light pollution control. These are considered in more detail below.

8.2.1.5 Mixed uses of hard and soft law in both common and civil legal systems

As stated above, a mixed use of hard and soft light pollution laws may also represent an opportunity to control light pollution. In accordance with soft and hard law, many foreign jurisdictions have taken into account the adverse impact of light pollution emissions by creating mixed uses of hard and soft light pollution laws. Mixed use relates to the inclusion of legally binding and non-legally binding standards within light pollution control. This means people and light practitioners have to compulsorily commit legally binding approaches for light pollution control and they may alternatively follow the substance of soft light pollution law because the soft law also has an alternative concept to deal with outdoor light pollution.

The source of hard light pollution law comes in several forms; such as, case law made by courts, statutory law enacted by the government, and other relevant written law established by environmental and planning authorities. Sometimes hard light pollution law is directly influenced by the soft light pollution law and its soft mechanisms that must be obtained by professional lighting bodies or professional astronomical bodies to achieve environmentally friendly or energy efficiency lighting. To reduce light pollution emissions, legislators and policy makers adopt soft law standards for new light fixtures and increase incentives for localities or municipalities' entities to invest in modern sources of energy efficient outdoor light, fully shielded light fixtures, and other relevant

soft mechanisms for controlling light pollution.

A mixed use of hard and soft light pollution laws may set out the major light pollution policies, measurable metrics and enforceable measures which concern the environmental, economic and social functions of outdoor lighting. However, there is a critical question of who is the subject of mixed use of hard and soft rules, which can vary from an official lighting authority, to people, municipalities or bodies within a sector, to all who engage in a particular outdoor lighting activity. A mixed use approach may be seen as an attempt to promote more cooperation and coordination between the public sector and professional bodies who participated in the hard law mechanism or contributed to the soft law governance. The main reasons for a mixed use approach are the necessity to ensure that legally binding and non-legally binding instruments have alternative choices and contain different degrees of hard and soft law control. For example, a mixed use may be less structured than hard law, relying on cooperative, joint light pollution problem-solving by local people, light industry stakeholders and light practitioners with greater flexible approaches for light pollution control by the official authorities or professional bodies and resulting in a mixed use totally or partially settling the sustainable or efficient lighting governance.

8.2.1.6 Comparative different metrics of soft and hard laws

As addressed as above, various examples of metrics for benchmarking acceptable or excessive light show the important though varied role of light pollution frameworks across legal systems, whereby the detailed implementation of global SI Unit metrics (i.e., level of upward light ratio of the installation (flux), vertical illuminance (lux), light intensity (Cd), luminance (Cd/m2) and curfew illuminance (lux)) can be delegated to official authorities and professional bodies. The degrees of acceptable or unacceptable outdoor lighting is generally defined in the categories of measurable metrics of levels, direction, brightness and other relevant harmful properties of light (i.e., speed, frequency, wavelength and electromagnetic waves of outdoor light). There is a very clear role of legally binding or non-legally binding metrics for controlling light pollution as mentioned above, but sometimes outdoor light pollution control metrics

themselves are not statutorily or legally defined by hard laws.

So, this research raises the question of how far the SI Unit metrics of both soft and hard laws can deliver desirable outcomes of controlling light pollution. Again, lighting governing authorities or professional bodies generally establish, implement and maintain a global SI Unit metric as a complementary metric within the category of light pollutant emissions. Each metric of SI Unit is constructed as an SI Unit ratio, with adverse impacts, either resource energy efficient consumption or light pollutant emissions, in the numerator and a representation of output, in environmental, social or financial terms, in the denominator.[526] Soft and hard laws sometimes establish a number of fixed SI Unit metrics of light pollution which constitute unacceptable or unnecessary level, direction and brightness of outdoor light, but they are not designed to encourage the new illuminating engineering development and use of innovative metrics that improve environmental protection. For example, inadequate metrics and measurement methods are part of the light pollution problem.[527] Therefore illuminating engineers and light scientists have recently developed a framework called box metric[528] which provides a set of means of quantifying how much light is leaving a lighting installation and establishes a measurement of light pollution.[529]

In addition, a metric for controlling light pollution may be a defined measure that people, light industry stakeholders and light practitioners are able to use to assess levels of light pollution and to characterise key elements of light pollution[530], but several metrics may link with other environmental pollution requirements to provide a systematic mechanism to identify main elements of light pollution and to evaluate the

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[526] Schwarz, J. M., Beloff, B. R., and Beaver, E. R., *Use Sustainability Metrics to Guide Decision-Making*, BRIDGES to Sustainability, 2002, pp 58-63.

[527] Claudio, L., 'Switch On the Night Policies for Smarter Lighting', *Environmental Health Perspectives* 2009 1 (117), pp 29-30.

[528] McColgan, M., 'Defining Light Pollution: Taking action against light pollution', 2004 (7) *IMSA Journal*, available from http://www.lrc.rpi.edu/resources/newsroom/pdf/2004/ShoeboxMetric.pdf accessed 28 August 2014.

[529] Lighting Research Centre, *Shoebox Metric: A Framework for Reducing Light Pollution*, available from http://www.lrc.rpi.edu/resources/newsroom/pdf/2004/ShoeboxMetric.pdf accessed 28 August 2014.

[530] Boyce, P.R. and Veitch, J.A., *Assessing Lighting Metrics*, International Commission on Illumination, Manchester, 28 June - 4 July 2015, p 1.

viability of linking the light pollution concept with other pollutions. For example, atmospheric light pollution may be referred because, in all sky areas, the colour (i.e. spectral frequency of outdoor light) should be consistent, unlike the ground or other randomly chosen surfaces. Is was assumed that it would be detected as sky glow, due to scattering of light by the major sources of air pollution (i.e., vehicle emissions, smoke, and dust) in the urban atmosphere.[531] So, it seems that the SI Unit metrics of both soft and hard laws deliver undesirable outcomes of controlling atmospheric light pollution in all legal systems, if their legislators and policy makers cannot ensure the prevention light pollution by, for example, linking light and air metric requirements to indicators of risk in the atmospheric pollutants or wider pollution indicators.

This subheading is not only concerned with the advantages of metrics, but it also notes the disadvantages of a fixed-effect metric of the levels of light pollution. Firstly, the primary goals of outdoor commercial lighting are to attract customers, to provide sufficient lighting for the evaluation of merchandise, and to facilitate completion of the sale.[532] Although outdoor commercial light is a source of light impacts, it still functions as an important economic facility in the surrounding communities by providing jobs and stimulating local economic activity.[533] If the outdoor commercial lighting of high district brightness is considered to be a market success as a result of perfect outdoor marketing information, the light pollution rules may make some common sense exceptions of environmentally friendly metrics, which allow light polluters to be used for business and commercial purposes. However, the economic incentives through the use of commercial outdoor brightness facilities generally provide a greater range of commercially friendly lighting metrics than environmentally friendly lighting metrics, such as a regulatory metric requiring a minimum brightness level for outdoor lights or a subsidy that privileges commercial outdoor lights in commercial and business town

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[531] McCawley, M., *Air, Noise, and Light Monitoring Results For Assessing Environmental Impacts of Horizontal Gas Well Drilling Operations (ETD-10 Project)*, West Virginia Department of Environmental Protection Division of Air Quality, 2013, p 14.

[532] Illuminating Engineering Society of North America, *Retail Lighting Applications*, available from http://www.ies.org/lighting/applications/interior-retail.cfm accessed 28 August 2014.

[533] McDowall, D. J., *Planning on Noise: The Implementation of Noise Compatibility Zoning in the. Northeast United States*, Master of Science in Urban Planning Thesis, Columbia University, 2012, p 37.

centres, which target only some successful economic solutions.[534]

Secondly, the high district brightness area is commonly zoned for commercial and industrial, but sometimes there are a set of areas designated for residential uses as well. In other words, many town centres have never had to deal with environmental light issues until now and are finding the need to tackle this concern by introducing acceptable metrics for balance in commercial, industrial and residential light pollution in urban areas.[535] So, a range of measurable metrics is of significance to the potential light sufferer in urban areas. On the other hand, some metrics are very competitive and to compete some create excessive or obtrusive brightness as means to attract commercial and industrial customers.[536]

Thirdly, the metrics are mainly for developers, their advisors and others who wish to gain a general understanding of light pollution metrics that have been developed for outdoor lights, based on a wide ranging acceptable standard as laid down in hard and soft law frameworks. However, the metrics of the maximum light level permitted in relation to some properties of light can neither be examined by environmental impact assessment or by legal measurement.[537] They may make use of assumptions on emission of key elements of light pollution, but these assumptions may differ from the actual operational lighting conditions. For example, the possible effects of blue rich light wavelength and flickering annoyance on human health and the night environment are very complex, and may need to be considered to address narrow metrics (which makes it easy to take consideration of the balance between outdoor lighting needs and public environmental interests).

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[534] Organisation for Economic Co-operation and Development, *Environmental Taxation: A Guide for Policy Makers*, available from http://www.oecd.org/env/tools-evaluation/48164926.pdf accessed 28 August 2014.

[535] Kinetics Noise Control, *Noise Ordinance*, available from http://www.kineticsnoise.com/industrial/noise_ordinance.html accessed 28 August 2014.

[536] Bedford Borough Council, *Noise and the Law*, available from http://www.bedford.gov.uk/environment_and_planning/pollution/noise_pollution/noise_and_the_law.aspx accessed 28 August 2014.

[537] Essen, H. P., Boon, B. H., Mitchell, S., Yates, D., Greenwood, D. and Porter, N., *Sound Noise Limits Options for a uniform noise limiting scheme for EU airports*, CE Solutions for environment, economy and technology, 2005, p 34.

Next, another disadvantage is that the fixed-effect metric of the levels of outdoor light for human health assessment, where an area to be lit lies on the overlap of share common boundaries of light and other environmental pollutants, may represent an inflexible solution in an environmental context.[538] For example, for most, a noisy flickering light display is usually considered an enjoyable light activity[539], but the same audience would probably consider the same source of outdoor flickering light as both noise and light nuisance if trying to sleep at night.[540]

Finally, there are remarkably large variations in artificial night sky brightness across the world[541] because the release of light pollutants into the urban atmosphere and their removal are on-going processes affected by source strengths, sunlight, moisture, clouds, rain, geography, and regional and local weather patterns.[542] The atmospheric smog brightness and appearance of urban sky glow depends on atmospheric factors, chiefly moisture, air pollution, and dust particles. Poor air quality has the opposite effect, increasing atmospheric smog brightness close to the source and degrading the natural dark-sky condition.[543] However, all relevant stakeholders have not yet started to carry out atmospheric sky glow metric, attempting to establish more reliable and more complex measurement response relationships between light pollution and air pollution.

This analysis of the disadvantages of a fixed-effect metric of the levels of light pollution brings legislators and policy makers to another critically important question: what needs to be done to commit to developing regulatory metrics to help better describe light

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[538] Washington State Department of Ecology, *Air Quality Maps of Maintenance Areas*, available from http://www.ecy.wa.gov/programs/air/other/namaps/Web_Map_Intro.htm accessed 28 August 2014.

[539] Cree, Flicker happens. *But does it have to?*, available from http://www.cree.com/~/media/Files/Cree/LED%20Components%20and%20Modules/XLamp/White%20Papers/Flicker.pdf accessed 28 August 2014.

[540] U.S. International Trade Commission, *Air and Noise Pollution Abatement Services: An Examination of U.S. and Foreign Markets Investigation No. 332-461*, U.S. International Trade Commission, 2005, pp 1-3.

[541] University of Exeter, *Night skies brightest in human history*, available from http://www.exeter.ac.uk/news/research/title_435353_en.html accessed 28 August 2014.

[542] State of New South Wales and Department of Environment, Climate Change and Water NSW, *Current air quality in New South Wales: A technical paper supporting the Clean Air Forum 2010*, State of New South Wales and Department of Environment, 2010, p 1.

[543] U.S. Department of the Interior National Park Service, *Measuring Lightscapes*, available from http://www.nature.nps.gov/night/measure.cfm accessed 28 August 2014.

pollution impacts? As mentioned above, this subheading recognises that certain metrics and parameters for dark-sky quality involving SI Unit measurements are desirable for effective light pollution control functioning and that light pollution regulations should undertake them due to involvement in a wide range of other legal reasons, based on scientific awareness. They constituted the appropriate brightness or dark-sky quality indicators to measure, based on time, need, and cost which should apply if they are permitted, and involve measures designed to reduce key elements of light pollution in regulatory requirements by valuation of environmental risks, aimed at preventing undesirable build up of excessive or obtrusive light pollution in the night environment. However, environmental law approaches may develop to fill the gaps of the uses of regulatory metrics. One approach may be use of regulatory metric to investigate whether the levelling of non-environmentally friendly light indicates that the dark-sky or brightness quality is increasing following the environmentally friendly and efficient use of outdoor lighting and whose failures to comply with the regulatory metrics would thus adopt several allocations of environmental responsibilities. Another approach may be the evolution of measurable metrics, which takes account of relationships between dark-sky quality parameters and other relevant environmental parameters, such as noise, air and economic quality metrics, in which the value of risk of human health and the night environment is indicated conditional upon the degrees of environmental harms.

Soft and hard laws are able to facilitate the progressive development of regulatory light pollution control, but a fixed-effect metric of the levels of light pollution should work with soft and hard laws, and other relevant environmental rules if necessary, to put in place a compulsory measurement to ensure that if a legally binding indicator is needed from a number of regulatory metrics to assess the quality of the night environment, it can be evaluated.

As this research discusses below, it revealed a number of soft and hard law standards set for light pollution reduction. It was due to legal system differences in baselines to improve from, municipal, regional and national rules, local problems and legal philosophies.

8.2.2 Separating the key examples of light pollution control laws

Taking into account trends for regulatory light pollution control, the laws and their legal systems could find that the specific legal methods to reduce unnecessary or inappropriate outdoor lighting would be through regulatory solutions. Although practically, the legal forces of light pollution control are understood as various sophisticated conceptualisations of soft or hard laws, as mention in Chapter 5, different legal systems usually face different challenges, and face different problems in their steps towards sustainable outdoor lighting.

The removal of barriers and differences would simplify shared standards for light pollution control which sharply impact on the unnecessary or non-environmentally friendly outdoor light uses in legal systems. Steps needed towards reforming common standards for light pollution control throughout comparative law to protect public and private environmental interests are able to benefit from comparative legal studies of differences and similarities between the regulatory frameworks. The fractures and diversity of key elements of light pollution control in different jurisdictions could be removed by integration of the common or shared requirements. The integrated legal aspects of light pollution control can explore responses to light pollution problems that may provide key trends of the light pollution laws that could potentially be adopted by legal systems.

In this subheading, we critically analyse existing regulatory standards to reduce light pollution from outdoor lights and summarise findings on the comparative legal studies[544] of differences and similarities between the existing light pollution of the key

[544] Despite the House of Commons Science and the Technology Committee and the Royal Commission on Environmental Pollution's publications such as *Light Pollution and Astronomy Seventh Report of Session 2002–03* and *Artificial Light in the Environment 2009* have previously reviewed some foreign light pollution laws and critically evaluated the future of regulatory reforms, the literature reviews from former publications cannot fulfil all aspects of light pollution requirements. They are not to show ordinary readers or academic specialists that the previous published work concerning a particular question in comparative law field has been critically discussed. See House of Commons Science and Technology Committee, *Light Pollution and Astronomy Seventh Report of Session 2002–03*, House of Commons Science and Technology Committee, 2003, pp 45-46. and see Royal Commission on Environmental Pollution, *Artificial Light in the Environment*, Royal Commission on Environmental Pollution, 2009, p 13.

jurisdictions[545], in particular where national and local laws are aimed at preserving dark-sky heritage and protecting environmental interests in relation to outdoor lighting practices recognised by the legal systems we were asked to address. In addition, the comparative law methods this research adopts in this Chapter is straightforward: by including a comparison on foreign light pollution requirements, along with a comprehensive set of comparing mechanisms, instruments, illuminating areas, illumination levels as well as shielding requirements that can relate to provide the minimum amount of lighting needed for environmentally friendly or energy efficiency purposes through light measurement. This documentary research uses an acceptable research method that is also social scientific and requires rigorous adherence to research comparative law.[546] However, key limitations of this comparative law research are particularly related to the lack of translated foreign law documents in the UK (i.e., Slovenian, Japanese, Italian, Chilean, French and Spanish jurisdictions).[547] Some is directly related to legal text and materials in a foreign language, other than English, that have not yet been accompanied by an official translation.[548] If any of comparative law research documents this research referred to are not in English, the original will be cited with foreign law document in the English version by the researcher. [549] This includes

[545] During the last few years there is recognition of light pollution problems through scientific studies and legal awareness. Light pollution is a very new discipline of the environmental and planning law as already mentioned in the previous chapters, but many countries and main legal systems have been given jurisdictions in matters arising under their national, regional and local regulatory frameworks. While some jurisdictions came to the stage of preventive light pollution control much later than England, they provide more effective provisions which contain the up-to-date rules for outdoor lighting practices to make them sustainable and safe and limit all sources of unnecessary or non-environmentally friendly outdoor lights at night. See Campaign to Protect Rural England, *Shedding Light: A survey of local authority approaches to lighting in England*, Campaign to Protect Rural England, 2014, p 6.

[546] Mogalakwe, M., 'The Documentary Research Method – Using Documentary Sources in Social Research', *Eastern Africa Social Science Research Review*, 2009 1 (25), pp 43-58.

[547] Gerber, D. J., 'System Dynamics: Toward a Language of Comparative Law', 1998 (719) *American Journal of Comparative Law*, available from http://scholarship.kentlaw.iit.edu/cgi/viewcontent.cgi?article=1247&context=fac_schol accessed 28 August 2014.

[548] Milian-Massana, A., 'Introduction', in Milian-Massana, A. (eds) *Language Law and Legal Challenge in Medium-sized Language Communities: A Comparative Perspective*, Generalitat de Catalunya Institut d'Estudis Autonòmics, 2012, pp 9-24.

[549] The problem of comparative law research with this translation solution is that lengthy explanations will be necessary for a great many terms, making the translation of even a short legal text so cumbersome that it cannot be achieved without an encyclopaedic volume of explanation in footnotes. See Curran, V.

various references of the key examples of foreign light pollution control laws from both civil and common legal systems.

8.2.2.1 Republic of Slovenia

In Slovenia, the *Decree on Limit Values due to Light Pollution of Environment (OG RS, No 81/2007) of Slovenia*[550] has brought artificial light from outdoor lighting premises under the most advanced legislation on light pollution for objects of culture heritage.[551] The Slovenian regulatory framework is essentially about illumination of outdoor lighting premises. It also allows the Slovenian public sector and local authorities to prevent poor illumination at night through appropriate fixtures and environmentally friendly design.

The *OG RS, No 81/2007) of Slovenia* offers some protective measures for outdoor lighting practices. Three main elements are required.[552] Firstly, the Slovenian law generally requires that all outdoor illuminating façades are based on legal criteria for the average value of the entire illuminated surface and the luminance measurements of the general outdoor premises. For example, legal practices of environmentally friendly luminaries which specifically designed outdoor lighting instruments that tackle the upward spread of light above the horizontal and brightness of the illuminated part of the façades must not exceed 1cd/m2. Secondly, Slovenian law specifically sets out a clear set of principles governing outdoor illuminating façades of cultural monuments and

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C., *Comparative Law and Language*, University of Pittsburgh School of Law Working Paper Series Paper 27, 2005, pp 1-45.

[550] Uradni list RS, *Uredba o mejnih vrednostih svetlobnega onesnaževanja okolja, Stran 11081*, available from http://www.uradni-list.si/1/objava.jsp?urlid=200781&stevilka=4162%20 accessed 2 September 2014.

[551] Life at Night project Euromix Ltd., *The Decree on Limit Values Due to Light Pollution of the Environment*, available from http://www.lifeatnight.si/en/index.php?option=com_content&view=article&id=128&Itemid=195 accessed 2 September 2014.

[552] The strictest light pollution legislation in the world has been adopted by the Slovenian Government in 2007 – the *Decree on Limit Values due to Light Pollution of Environment (OG RS, No 81/2007)* of Slovenia allows no light at all above the horizon. On the other hand, there are no specific laws that seek to protect harmful environmental impacts of light pollution in the UK, although some forms of artificial lights can be classified as a statutory nuisance. See further European Commission, 'Street lighting affects insect biodiversity', *Science for Environment Policy GDG Environment News Alert Service*, 2012 July, p 1.

historical buildings. It also requires that average façades luminance must be less than 1cd/m2. Thirdly, the purpose of Slovenian law is also to reduce the potential impact of artificial lighting on endangered species by restricting outdoor lighting that may affect the night environment, which was an impact on their nocturnal life at night. The principle of light pollution protection in relation to endangered species was adopted by this Slovenian framework, which includes preliminary aims to conserve either endangered or threatened species under the previous Slovenian conservation legislation, such as the Framework Nature Conservation Act (OG RS, No 96/2004), the Decree on Ecologically Important Areas (OG RS, 48/2004), the Decree of Protected Wild Animal Species (OG RS, No 46/2004), and the Decree on Special Protection Areas (Natural 2000 Sites) (OG RS, No 49/2004).

In designing a number of new specific Slovenian light pollution measures, as mentioned above, Slovenia must carry out the obligations and responsibilities of the light pollution control involved[553], ensuring that there are clear recommended levels of illumination for outdoor lighting. However, while addressing specific concerns about some light pollution problems and some legal aspects of light pollution are, the preliminary purposes, this legislation may not contribute to reinforcing all of Slovenia's light pollution problems in all environmental and planning concerns. This legislation does not include a comprehensive set of all light pollution aspects and therefore our comparative study of light pollution law for legal reform purposes add to them as referred in the following subheadings.

There are three findings which are significant to strengthening the Slovenian environmental system. They take into account specific light pollution control purposes in ecological protection, heritage site conservation as well as energy efficiency of outdoor light. These would also strengthen Slovenian light pollution control actions, such as the regulatory measures, which involve the Slovenian mechanisms of light pollution prevention, and the regulatory metrics, which fully support the SI Unit light pollution measurements. However, a weakness of understanding the interconnections

[553] Prelovšek, M., Bizjak, G., and Kobav, M., 'Public lighting energy consumption in Slovenian municipalities from 2007 to 2011', *Elektrotehniški Vestnik*, 2012 79 (3), pp 87-92.

between all aspects of light pollution in the Slovenian legal system has been a key factor in the Slovenian legal problems. A lack of harmonisation of Slovenian policies and regulatory frameworks raises a number of legal problems because the fragmentation of purposes activities in each Slovenian framework are difficult to set up, which may lead to light industry stakeholders and light practitioners not being able to fully take advantage of the Slovenian regime. For example, a multi-purpose regulatory framework may be prepared, in accordance with a single national framework and in collaboration with all Slovenian authorities and stakeholders, in order to find the illuminating engineering evidence base underpinning Slovenia's environmental assessment, the light pollutants of concern, and where and how light pollution is measured and modelled by zoning for outdoor lighting control within a single urban development plan under key legislation relating to national light pollution control. A single framework may be needed to ensure that the balance between all purposes approaches for environmentally friendly lighting practice will be advantaging the benefits of single national harmonised metrics and ensuring that the Slovenian legal system is able to operate in effective and efficient actions for national outdoor lighting practices.

8.2.2.2 Japan

In Japan, the light pollution law came into effect in Bisei town, Okayama prefecture in Japan because of the setting of a dark- sky conservation zone in the town. It is the largest dark-sky area where the Bisei Astronomical Observatory (BAO), one of several distinguished observatories in Japan, was established in 1993 and the Government of Bisei - Town intended it to serve as an educational and research facility for public use.[554] This local Government also was set up the *Optical Environmental Disruption (Light Pollution) Prevention Ordinance in Bisei 1989* to allow local authorities to control outdoor lighting practices.[555] The objective of this legislation was to protect light pollution at night and astronomical observatory interests while guaranteeing the

[554] Bisei Astronomical Observatory, *Introductory guide to Bisei Astronomical Observatory*, available from http://www.bao.go.jp/eng/sisetu.htm accessed 9 September 2014.

[555] Isozaki, H., *The Right to the Starlight in Legislation: International, National and Local Laws and Regulations*, available from http://www.starlight2007.net/pdf/proceedings/Isozaki.pdf accessed 9 September 2014.

effective operation of benefiting from national astronomical research and local dark sky tourism.[556] It established a number of significant reforms to astronomical light pollution control enforcement in Bisei astronomical observatory areas where Bisei Town's intrinsically dark landscape is the regulatory term given to specific environmental zones for outdoor lighting control that are relatively free from light pollution at night, and professional and amateur astronomers will be given reasonable opportunity to view the dark skies in Japan.

The *Optical Environmental Disruption (Light Pollution) Prevention Ordinance in Bisei 1989* has a limited role just in Bisei Town's light pollution matters. Therefore, the legal aspects of light pollution control were specifically created to bring into local law in Bisei Town. It provides a number of specific provisions to control outdoor lights in order to reduce adverse consequences for astronomical observatory research[557], the dark-sky environment (including dark-sky heritage) and outdoor astronomy activity.[558] Where risks of astronomical light pollution impacts arise as an unavoidable and integral element of the Japanese astronomical research, these provisions must be regulated and complied with.[559]

The primary purpose of this local law was to incorporate some legal aspects of astronomical light pollution prevention into by-laws of Bisei's jurisdiction.[560] Unfortunately, Japanese environmental and planning law does not contain the necessary or appropriate provisions providing many legal mechanisms for light pollution prevention across all local authority jurisdictions in respect of all aspects of local or municipal Japanese light pollution problems, for example, an external lighting curfew, a

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[556] Ochi, N., 'An example of energy and environmental education through light pollution' *Journal of Energy and Environmental Education*, 2010 4 (2), pp 57-65.

[557] Gardner, C., 'Tackling Unwanted Light: An International Perspective', *Light & Engineering*, 2012 1 (20), pp 24-39.

[558] Ogata, T., *Environmental Administration in Japan and the Role of Local Governments*, Papers on the Local Governance System and its Implementation in Selected Fields in Japan No.7, Japan, available from http://www3.grips.ac.jp/~coslog/activity/01/04/file/Bunyabetsu-7_en.pdf accessed 9 September 2014.

[559] Ministry of the Environment, *Annual Report on the Environment in Japan 2003: Local Communities Leading the Transition to a Sustainable Society*, Ministry of the Environment, available from http://www.env.go.jp/en/wpaper/2003/07.pdf accessed 9 September 2014.

[560] Isobe, S. and Sugihara, N. 'Light-Pollution Prevention Ordinance in the Town of Bisei', *Proceedings of the Astronomical Society of Australia*, 1991 9 (2). 336.

ban on outdoor light emissions above the horizontal level, a ban on sign lighting to come from the top of signboard, a ban on low-pressure sodium lamps, and a ban on all use of upward laser beam displays.

Likewise, when the preliminary concerns of national light pollution problems in the Japanese jurisdiction where a lack of regulatory light pollution protection still exists in the current Japanese legal system with respect to which a number of national light pollution problems has been underlined by the Japanese environmental and planning agencies, the Japanese environmental and planning policy frameworks have recently underlined necessary guidance for national light pollution control in Japan. They recently adopted non-legally binding measures which clearly demonstrate that unacceptable illumination or non-environmentally friendly lighting practices should be considered by either the Japanese environment agency or under the Japanese planning control approval, which can be found for example on the *Light Pollution Control Guidelines 1998 and 2006 (1998 Guidelines and 2006 Guidelines)*, the *Manual for Local Planning of Lighting Environment 2000*, and the *Guidebook on Light Pollution Preventive Measures 2001*.[561]

However, current problems in the Japanese legal system involve situations in which an attempt to meet national light pollution prevention are hampered by several weaknesses, including a lack of regulatory measurable metrics, insufficient legislative enforcement, insufficient reform of national legislative errors, and inadequate light pollution awareness. Of course, Japanese guidelines, manuals, and guidebooks as soft laws also have advantages, notably in that the non-legally binding commitments and the light pollution may be reduced by implementing these technical standards, practical methods and measurable metrics, thus increasing appropriate or necessary outdoor lighting with flexible rather than fixed light pollution control. Arguably, hard law would lead to greater light pollution control at national level in the Japanese legal system because it is able to incentivise Japanese authorities, light industry stakeholders and people to

[561] Hong Kong Legislative Council Commission, *Information Note: Light pollution and the regulation of outdoor lighting in selected places*, available from http://www.legco.gov.hk/yr08-09/english/sec/library/0809in08-e.pdf accessed 9 September 2014.

increase legally binding responsibility and legal awareness. There are a few arguments in favour of a minimum integration of Japanese hard law frameworks, with Japanese local authorities allowed to set different levels and metrics of outdoor light emissions above the minimum standard of Japanese soft laws.

8.2.2.3 Italy

In Italy, Italian light pollution legislation, which has been taken into account in tackling light pollution in Italian regional jurisdictions[562], is based on, or influenced by, the role of written legislation and the codified law system.[563] The regional legislative instruments have a different significance depending on whether the Regional Governments promulgate regional laws or regional provisions are adopted by the Regional Councils. Therefore, many sources of Italian light pollution law are those written rules, regulatory provisions, and legal aspects that have been enacted, adopted or recognised by the Regional Governmental Bodies.

Since 2000, some Italian Regional Governments have proposed reforms to the regional light pollution law aimed at enhancing dark-sky preservation and environmental protection in Italy so that non-environmentally friendly lights or unnecessary lights can be tackled in an integrated approach and each Italian Region can focus efforts on where it can make the most effective regionally as well as locally.

Italian regional light pollution laws have been enforced in 15 Italian Regions (*Lombardia 17/00*, *Emilia-Romagna 113/03*, *Marche 10/02*, *Lazio 23/00*, *Campania 13/02*, *Veneto 22/97*, *Toscana 37/00*, *Piemonte 31/00*, *Valle d'Aosta 17/98*, *Basilicata 41/00*, *Abruzzo 12/05*, *Umbria 20/05*, *Puglia 15/05*, *Friuli-Venezia Giulia 15/07*, *Liguria 22/07*) which cover more than two thirds of the Italian population and the main

[562] Italy is divided into main 20 regions and each main region is comprised of provinces and municipalities under the Constitution of the Italian Republic (Costituzione della Repubblica italiana) 1948. The Italian Constitution decentralised the power for environmental and planning control in relation to light pollution prevention. See Treu, M. C., Magoni, M., Steiner, F., and Palazzo, D., 'Sustainable landscape planning for Cremona, Italy', *Landscape and Urban Planning* 2000 (47), pp 79 - 98. and see also Stuart, C., *Comparative Political Decentralisation in Europe*, Scottish Parliament Information Centre, 2009, pp 23-27.

[563] Baschiera, M., 'Introduction to the Italian Legal System: The Allocation of Normative Powers: Issues In Law Finding', *International Journal of Legal Information* 2006 2 (34), 2006, pp 279-326.

cities[564] (Milano, Roma, Venezia, Firenze, Bologna, Napoli).[565]

For example, *Lombardia Regional Light Pollution Law 17/00* (*Legge della Regione Lombardia n. 17/00 del 27/03/2000*)[566], the first Italian Regional Framework for light pollution reform, sets out how Lombardy's Regional Government will make a regulatory approach for environmental lighting practices to set minimum standards for the protection of Lombardy's night environment. It is the first piece of Italian legislation at Regional level that introduced various legal aspects of Regional light pollution control, which is a list of written articles that must always be practiced when people use outdoor lighting premises, or when manufacturers, importers, suppliers and distributors store and place their outdoor light products on the market for third parties. There are also restrictions on regional outdoor lighting, some forms of light pollution are restricted or prohibited, and there are requirements for regional outdoor lighting practices to be held and for bans on non-environmentally friendly lights and unnecessary lights. The requirements include environmental zoning for protection of the astronomical observatories, plans of new outdoor light installations, environmental safety requirements of efficiency outdoor light sources, curfew hours, and restrictions on specific light premises.[567]

However, inadequacy of the national harmonised regulatory environment in Italy is a significant issue that plays to all Italian national dark-sky protection agendas. The problem is that although these Italian regional measures for outdoor lighting practices

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[564] Cinzano, P., *La valutazione dell'impatto ambientale dell'inquinamento luminoso*, Relazione presentata al Convegno Nazionale Immissioni ed Emissioni, Milano 14 Dicembre 2004, available from http://cielobuio.org/supporto/download/cinzano_impatto accessed 10 September 2014.

[565] Cinzano, P., *Laws against light pollution in Italy*, available from http://www.lightpollution.it/cinzano/en/page95en.html accessed 10 September 2014. and also see Dark Skies Awareness IYA 2009 Cornerstone Project, *Regione Veneto in Italy approves a law promoting no upward-directed light!*, available from http://www.darkskiesawareness.org/veneto-law.php accessed 10 September 2014.

[566] Professional Eco-Light Association, *Legge della Regione Lombardia n. 17/00 del 27/03/2000 e s.m.i.*, available from http://www.lightis.eu/index.php?option=com_content&view=article&id=103:legge-1700-indice&catid=66:cat-leggi-italia&Itemid=86 accessed 10 September 2014.

[567] Coordinamento per la protezione del cielo notturno, VISUAL Accomplishment Regulationsfor the R. L. 17/00, available from http://www.cielobuio.org/cielobuio/lrl17/visualreg17en.htm accessed 11 September 2014.

are based on each regional regulatory framework, they are not applied in the same way everywhere in Italy. This is because different Italian Regional Parliaments have adapted the rules to comply with different Italian Regional jurisdictions. As a result, many of the regional jurisdictions in Italy do not take account of light pollution control, requiring regional bans on outdoor light pollution, either by control of poor outdoor lighting or by control of non-environmentally friendly sources of outdoor lights.

In addition to the lack of clarity in the Italian national agenda for harmonised light pollution control at a national level, this also means that it is difficult for Italian regulatory bodies to identify the most effective measures which are a key response to Italian national light pollution problems. With the adoption of the emergence of the single concept of Italian national light pollution control, concerns such as the dark-sky preservation, night environment protection and Italian people's health should be enshrined in Italian national environmental and planning law, alongside the priority of night environment protection.

There are several findings which are significant to strengthening the Italian legal system. Firstly, an important potential strength of various Italian Regional Frameworks is the establishment of energy efficiency objectives, light pollution control goals, illuminating engineering indicators, and certain measurable metrics as a basis for evaluating and quantifying of outdoor light. The regulatory measurable metrics of the Italian Regional Frameworks are used to quantity directions and levels of non-environmentally friendly or unacceptable light. They define the SI Unit metrics that play a significant role in assessing the degrees of light pollution in Italian legal system. [568] For example, deciding whether outdoor light fixtures and design would be likely to have adverse impacts on human health and the night environment compulsorily requires checking against some efficiency of average lamp life (hours) set by the regulatory SI Unit metrics (lumens/watt) and then against the adjustment on the outdoor light installations set out by the fixture and design requirements. It is for the Italian Regional Governments and local authorities to decide whether the adverse impacts are likely to

[568] Cinzano, P., *VISUAL Accomplishment Regulations for the R. L. 17/00*, available from http://cielobuio.org/cielobuio/lrl17/visualreg17en.htm accessed 15 September 2014.

be potential, taking account of regulatory measurement from local authorities, where necessary.

Each Italian Region delivers effective, efficient and enforceable regulatory light pollution control metrics that better meets the needs of the light practitioners, light industry stakeholders and people. Every Regional jurisdiction of the Italian legal system allow light pollution rules in the local authorities and public sector of environment, planning development, and energy to be focused on delivering environmental and energy benefits for Italian people. So, the Italian legal system has a modern regime with a number of Regional regulatory frameworks which meet best practice, allowing local authorities and their people to response to light pollution problems while providing awareness for all relevant stakeholders.

However, this research raises the question of whether such legislative variations among the different Italian Regional jurisdictions gain dominance and significance in light of the proposed inter-jurisdictional sharing of national cooperative prevention and coordinative precaution across Regions. An advantage of self-regional light pollution law establishment, highlighted in different ways by many of regulatory metrics and legal mechanisms enacted, is that it can enable the light pollution issues from Regions and localities in the legal procedure to be drawn on more specifically. On the other hand, several Regional jurisdictions have neither harmonised, nor integrated an intention to set, national metrics, mechanisms and instruments to bring them into closer harmonisation of Italian light pollution law. If harmonisation with each Regional law is weak it is more difficult to set up a single national light pollution law in the Italian legal system. Another disadvantage is that there is a variety of self-regional regulations in the Italian legal system and it is not easy to evaluate the effectiveness of each Italian Regional regulation because diversity of regional and local light pollution problems in Italy has been a defining feature of self-regional regulation and it is very difficult to harmonise and integrate all Italian regional law together.

8.2.2.4 Spain

In Spain, at a national level, the Spanish Government would like to reduce the issues of

astronomical light pollution and, given the national responses for astronomical light pollution awareness, needs to ensure that regulations protecting astronomical observatory areas from the emission of outdoor light pollutants are administered by the Astrophysics Institute of the Canary Islands (IAC) as a main national governing body of Spanish astronomy observatory. As set out in the Spanish Government's response to international dark-sky awareness, the *Law 31/1988 on the Protection of the Astronomical Quality of the IAC ´s Observatories*[569] (*LEY 31/1988 de 31 de octubre, sobre Protección de la Calidad Astronómica de los Observatorios del Instituto de Astrofísica de Canarias*) adopted the strong commitment to improving dark-sky quality in the Canary Islands' astronomical dark-sky landscapes by setting legally binding standards for light pollution control. The Spanish Government also adopted the *Royal Decree Law 243/1992, which the Law 31/1988 on the Protection of the Astronomical Quality of the IAC´s Observatories* (*REAL DECRETO 243/1992, de 13 demarzo, por el que se aprueba el Reglamento dela Ley 31/1988, de 31 de octubre, sobre protección de la calidad astronómica de los Observatorios del Instituto de Astrofísica de Canarias*)[570] as a national regulatory proposal for a directive on dark-sky quality and environmental brightness quality at the same criteria as it adopted the *Law 31/1988* as referred above.[571] While theses Spanish frameworks are more effective and focused than various previous Spanish environmental and planning laws, both pieces of legislation have the same aim: to provide an intrinsically dark landscape where every professional and amateur astronomer has the opportunity to observe the sky objects, and to exemplify the Canary Islands' environmental zones for exterior lighting control within the *IAC's Sky Quality Protection Technical Office's subordinate lighting rules*, for example, requirements for eco-friendly level of illuminance in *lux (lm/m2)*, requirements for good uniformity of lights, and requirements for correct choice of luminaire.

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[569] Instituto de Astrofísica de Canarias, *LEY 31/1988 de 31 de octubre, sobre Protección dela Calidad Astronómica de los Observatorios del Instituto de Astrofísica de Canarias*, available from http://www.iac.es/adjuntos/otpc/leycielo.pdf accessed 15 September 2014.

[570] Instituto de Astrofísica de Canarias, *REAL DECRETO 243/1992, de 13 demarzo, por el que se aprueba el Reglamento de la Ley 31/1988, de 31 de octubre, sobre protección de la calidad astronómica de los Observatorios del Instituto de Astrofísica de Canarias*, available from http://www.iac.es/adjuntos/otpc/regcielo.pdf accessed 15 September 2014.

[571] Instituto de Astrofísica de Canarias, *The Sky Law*, available from http://www.iac.es/eno.php?op1=4&op2=10&lang=en accessed 15 September 2014.

Such a national protection of astronomical light pollution, however, does not totally control the levels of non-environmentally friendly or unnecessary lighting emissions throughout the Spanish Nation. As a result, it does not ensure that a night environment standard in relation to outdoor lighting practices, specifying a maximum permissible level of the lighting, would be met throughout Spanish jurisdiction.

Therefore, some Spanish Regions, such as the Catalan Region and Andalucía Region, have recently adopted a number of legal mechanisms for reducing the main aspects of light pollution. In Catalonia, autonomous regional jurisdiction, the *Catalonian Law 6/2001, on Environmental Regulation of Lighting for the Protection of the Nocturnal Environment* (*Llei 6/2001, de 31 de maig, d'ordenació ambiental de l'enllumenament per a la protecció del medi nocturn)*[572] was enacted as a reaction to a number of key elements of non-environmentally friendly lights or unnecessary lights at night.[573] This Catalonia framework requires its municipal or local authorities to reduce urban light pollution to bring the environmental areas for outdoor lighting control within regulatory enforcement and into attainment with certain regulatory standards for intrusive or excessive lighting limits of poor outdoor fixtures and design. This law delegated various aspects of light pollution through representing the first steps toward establishing the chosen measures of Catalonia light pollution prevention, for example, the definitions of light pollution, the legal aspects of light pollution control associated with illuminating engineering techniques and architectural lighting design, the environmental zoning, the requirements of full horizontal cut off luminaries, the requirements of environmentally friendly sources of lights, and other limits on light pollution emission.

Similarly, in Andalusia, autonomous regional jurisdiction, the *Decree 357/2010, August 3rd, which approves the regulations for the protection of the night sky quality against light pollution and the establishment of measurements for energy saving and efficiency* (*Decreto 357/2010, de 3 de agosto, por el que se aprueba el Reglamento para la*

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[572] Parlament de Catalunya, *Llei 6/2001, de 31 de maig, d'ordenació ambiental de l'enllumenament per a la protecció del medi nocturn*, Parlament de Catalunya, 2002, pp 1-35.

[573] Sako, M. J. L., 'Light Pollution Regulatory Issues in Spain', 2011 (6) *European Energy and Environmental Law Review*, available from http://www.kluwerlawonline.com/document.php?id=EELR2011008 accessed 16 September 2014.

Protección de la Calidad del Cielo Nocturno frente a la contaminación lumínica y el establecimiento de medidas de ahorro y eficiencia energetic)[574], came into force on 3 August 2010 and adopted the significant aspects of regional light pollution control into Andalusia Regional jurisdiction.[575] It will also give municipality and locality greater dark-sky preservation and night environment protection in Andalusia, and across the region, by providing a high autonomous regional standard for outdoor lighting practices through environmental zoning for outdoor lighting control and other requirements for light pollution prevention.[576]

While the Catalonia and Andalusia Autonomous Regional Governments prohibit a number of specific outdoor lighting practices that are listed in the *Catalonian Law 6/2001* and the *Andalusia Decree 357/2010*, as referred to above, there is no a single national light pollution framework in Spain that can be used to tackle all autonomous regional areas of Spanish jurisdiction handled by harmonised regional legislation. It currently seems increasingly likely that Spanish regulatory instruments cannot play a significant role in meeting the Spanish nation's future aims of national light pollution control.

8.2.2.5 Chile

In Chile, the *Emission Standard for the Regulation of Light Pollution – Supreme Decree N°686/98 Ministry of Economy* (*D.S. Nº 686/98 del Ministerio de Economía Fomento y Reconstrucción - Norma de emisión para la regulación de la contaminación lumínica*)[577] as a first Chilean law on light pollution control[578] provides measures on

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[574] Junta de Andalucía, *Boletín Oficial de la Junta de Andalucía - Histórico del BOJA: Boletín número 58 de 26/03/2014*, available from http://www.juntadeandalucia.es/boja/2014/58/2 accessed 16 September 2014. and Junta de Andalucía, *Boletín Oficial de la Junta de Andalucía - Histórico del BOJA: Boletín número 159 de 13/08/2010*, available from http://www.juntadeandalucia.es/boja/2010/159/2 accessed 16 September 2014.

[575] Revista del Colegio Oficial de Físicos, *Contaminación Lumínica: La Respuesta de la Administración Andaluza, Revista del Colegio Oficial de Físicos*, available from http://www.cofis.es/pdf/fys/fys21/fys21_30-31.pdf accessed 16 September 2014.

[576] Kyba, C.C.C., Hanel, A., and Holker,F., 'Redefining efficiency for outdoor lighting', 2014 (6), *Energy & Environmental Science*, available from http://userpage.fu-berlin.de/~kyba/publications/2014_Kyba_Redefining_Efficiency.pdf accessed 16 September 2014.

[577] Comisión Nacional del Medio Ambiente, *D.S. Nº 686/98 del Ministerio de Economía Fomento y*

written statutory provisions for astronomical light pollution prevention in northern Chile. This law is comprised of a single national framework which is underpinned by a range of astronomical observatory problems, illuminating engineering techniques, and energy saving incentives to areas of light pollution control. It specifically aims to reduce the adverse impacts of outdoor astronomical areas and increase the quality of dark-sky environment in Antofagasta, Atacama and Coquimbo Regions.[579] The Antofagasta, Atacama and Coquimbo Regional Governments and their municipal authorities have to specify the environmental zones for outdoor lighting control within their planning and environmental developments through the effective requirements to enforce the relevant written measures in their astronomical authority areas.[580]

The key purpose of the *Emission Standard for the Regulation of Light Pollution – Supreme Decree N°686/98 Ministry of Economy 1998* is also to reduce and manage the risks that light pollution pose to astronomical observatory landscapes, the night environment, astronomical heritage and Chilean astronomers' outdoor astronomical activity. Its regulatory provisions require Antofagasta, Atacama and Coquimbo municipalities to first carry out preliminary measures to identify the astronomical quality of the northern Chilean night sky and associated astronomical areas at risk of non-environmentally lights or unnecessary lights at night.[581] For such regional areas they would then need to enforce bans on non-environmentally friendly lighting practices

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Reconstrucción - Norma de emisión para la regulación de lacontaminación lumínica, available from http://www.vialidad.cl/areasdevialidad/medioambiente/Documents/Normativa/Normas%20de%20Calidad/DS86CONTAMINACIONLUMINICA.pdf accessed 11 September 2014.

[578] UNESCO Astronomy and World Heritage, *Short Description (ICOMOS-IAU Case Study format):AURA Observatory, Chile (multiple locations): General description*, available from http://www2.astronomicalheritage.net/index.php/show-entity?identity=43&idsubentity=1 accessed 11 September 2014.

[579] Ministerio del Medio Ambiente, *Chapter 10: Skies for Astronomical Observation*, available from http://www.mma.gob.cl/1304/articles-52016_Chapter10.pdf accessed 11 September 2014.

[580] Cerro Tololo Inter-American Observatory, *Manual de Aplicación – Norma de Emisión para la Regulación de la Contaminación Lumínica*, Cerro Tololo Inter-American Observatory, 1999, pp 1-49. and see further República de Chile Ministerio de Economía Fomento y Reconstrucción, *Establece norma de emisiónpara norma de emisión para la regulación de la contaminación lumínica*, Chile Ministerio de Economía Fomento y Reconstrucción, 1999, pp 1-9.

[581] Sanhueza, P., Schwarz, H. E., and Smith, M. G., 'The OPCC Experience in Protecting the Skies of Northern Chile' in Marín, C. and Jafari, J., *Starlight: A Common Heritage*, International Initiative in Defence of the Quality of the Night Sky and the Right to Observe the Stars, 2007, pp 427-434.

and establish enforcement on astronomical light pollution focused on prevention, protection and preparedness. For example, this approach often allows regional municipalities to deliver a number of outdoor lighting restrictions, such as limits to the general luminance emission, limits to luminous intensity, spectral radiance emission, limits to the luminance emission by reflection over the highway, and other requirements for standardisation of outdoor light use i.e. schedules in which illumination of exterior façades, standards of new light-emitting diode (LED) lighting innovation, cut-off angle requirements, and restrictions on the use and illumination of luminous signs.[582]

However, there is one major challenge to light pollution control in Chile. It might be argued that the ultimate goal of existing light pollution control law in the current regime of Chilean light pollution control should be to prevent increases in all aspects of Chilean light pollution across country. Within Chilean jurisdiction, there are various urban brightness areas that cannot satisfy the international dark-sky criteria for defining such a national pollution agenda, because there is no single regulatory framework at a national level, and because of the lack of specific environmental and economic incentives.

8.2.3.6 France

In France, the first French legal aspects of light pollution were delivered by Article 41 of the *law n°2009-967 of 03 August 2009 relating to the implementation of the Grenelle Environment project* (*La loi Grenelle I, ou loi n° 2009-967 du 3 août 2009 de programmation relative à la mise en œuvre du Grenelle de l'environnement*).[583] In this first provision, based on the national light pollution concerns[584], the brief context of light pollution was taken as the national subject for the growth of French non-

[582] Valenzuela, L., 'Case 4: Regulation of emission standards for light pollution (D.S. N° 43, de 2013, Ministry of Environment', in *Federal Commission of Regulatory Improvement, Regulatory Impact Evaluation Guide Vol II. Case Studies*, Federal Commission of Regulatory Improvement (COFEMER) & Asia-Pacific Economic Cooperation (APEC), 2013, pp 32-40.

[583] Legifrance, *LOI n° 2009-967 du 3 août 2009 de programmation relative à la mise en œuvre du Grenelle de l'environnement*, available from http://www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000020949548&categorieLien=id accessed 11 September 2014.

[584] Le Gue, A., *Petite histoire de la lutte contre la pollution Lumineuse*, l' Association l' Association Light Control Brightness Night Environment Sky Survey (LICORNESS), 2012, pp 1-36.

environmentally friendly or inappropriate outdoor light fixtures and design[585] in recent decades and define the different forms of light pollution made by excessive or obtrusive outdoor lights at night. While this law has strengthened legal awareness of light pollution at all levels to implement effectively suitable light pollution prevention of all types of outdoor lights and to achieve the shared responses on national light pollution problems, this French law does not provide necessary and proportionate measures for reaffirming national commitment to the previous environmental frameworks, including all legal aspects of light pollution control and all principle of sustainable lighting energy, as mentioned below.

Moreover, the French National Association for the Protection of the Sky and the Nocturnal Environment (L'Association nationale pour la protection du ciel et de l'environnement nocturnes - ANPCEN) had requested that French environmental bodies to adopt the Article 41 of *law n°2009-967 of 03 August 2009 relating to the implementation of the Grenelle Environment project* through creating guidance for astronomical and environmental authorities in France on environmentally friendly quality of outdoor lighting at night. The *French ANPCEN Plan for Sky and Night Environment Protection* (*ANPCEN Charte de protection du Ciel et de l'Environnement Nocturne*) is a comprehensive set of professional standards and guidelines for French national, regional or local light pollution control.[586] This Charter previously introduced cooperation with relevant multilateral astronomical and environmental bodies in order to facilitate enhanced cooperation to achieve the purpose of the non-legally binding instrument on all types of astronomical and environmental light pollution. The choice of this non-legally binding framework in light pollution control has been the subject of ever-increasing astronomical and environmental interest. Unfortunately, it does not exist because it is not enforceable, by the fact that it is not in itself legally binding.

Recently, a number of French specific measures for light pollution control were

[585] Syndicat Intercommunal d'Energies de Maine et Loire & Association Nationale pourla Protection du Cielet de l'Environnement Nocturnes, *Des économies d'énergieet une qualité de la nuit*, Association Nationale pourla Protection du Cielet de l'Environnement Nocturnes, 2014, pp 1-4.

[586] Association Nationale pour la Protection du Ciel et de l'Environnement Nocturnes, *ANPCN Charte de protection du du Ciel et de l'Environnement Nocturne*, Association Nationale pour la Protection du Ciel et de l'Environnement Nocturnes, 2011, pp 1-9.

mentioned in the *French Environmental Code* (*Legislative Part, Book V (Prevention of pollution, risks and nuisance, Part VII (Protection of the living environment), Chapter III (Prevention of light pollution, Articles R.583-1 to R.583-6)*)[587] and the *Order of 25 January 2013 concerning the lighting of non-residential buildings at night in order to limit light pollution and energy consumption* (*Arrêté du 25 janvier 2013 relatif à l'éclairage nocturne des bâtiments non résidentiels afin de limiter les nuisances lumineuses et les consommations d'énergie*).[588] These regulatory frameworks are intended to focus on national light pollution problems. In doing so, they cover necessary measures for light pollution control that aim to increase essential practices for light pollution prevention and to facilitate the duties on a French municipal authority in relation to statutory artificial light nuisance.[589] For example, from 1st July 2013, interior lights in business offices and other non-residential buildings, including shop windows will have to be switched off an hour after the last worker has left and the requirements for turning off outdoor business or commercial lighting at night between 1 am and 7 am is also to serve as a basis for effective use of exterior light premises at night.[590]

The advantages of existing light pollution provisions in the French jurisdiction include many legislative ways of preventing light pollution from business premises, retail developments and other commercial buildings in urban areas, understanding of the potential concerns of business or commercial light pollution and other reasonable or proportionate practices benchmarking for energy efficiency lighting at night (i.e.,

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[587] Ministère de l'écologie, du développementdurable et de l'énergie, *Circulaire du 5 juin 2013 - relative à l'éclairage nocturne des bâtiments non résidentiels afin de limiter les nuisanceslumineuses et les consommations d'énergie*, Ministère de l'écologie, du développementdurable et de l'énergie, 2013, pp 1-7.

[588] Legifrance, *Arrêté du 25 janvier 2013 relatif à l'éclairage nocturne des bâtiments non résidentiels afin de limiter les nuisances lumineuses et les consommations d'énergie*, available from http://legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000027003910&categorieLien=id accessed 11 September 2014.

[589] Parcs Nationaux de France & l'Association Nationale pour la Protection du Ciel et de l'Environnement Nocturnes, *Nuisances lumineuses et espaces protégés : UN PARTENARIAT POUR L'ACTION ENTRE PNF et ANPCEN*, Association Nationale pour la Protection du Ciel et de l'Environnement Nocturnes, 2014, pp 1-4.

[590] Ministère de l'écologie, du développementdurable et de l'énergie, *Mise en oeuvre de l'arrêté du 25 janvier 2013 relatif à l'éclairage nocturnedes bâtiments non résidentielsafin de limiter les nuisances lumineuseset les consommations d'énergie*, Ministère de l'écologie, du développementdurable et de l'énergie, 2014, 1-10.

switching off the lights when an area is vacated). However, given the existing concept of 1 am – 7 pm curfew hours for reducing maximum lighting hours at night as a subject for this French law it might be argued by this research that French law does not include all sources of unnecessary or inappropriate lights in the wrong place at the wrong time. In fact some forms of light pollution had been reviewed as previous ANPCN recommendations with mention of the need to include all necessary or proportionate measures for the protection of public astronomical and environmental interests as referred to above, nonetheless these existing provisions do not recognise that French people will need to control their outdoor lights for all inappropriate or non-environmentally friendly purposes of their outdoor light uses. This means that it is sufficient to argue that all aspects of light pollution control are necessary because all of the precautionary or preventive approaches for light pollution control that could have been in a number of precautionary proposals were available elsewhere and were taken into account before the current provisions were enforced; or that had a number of precautionary or preventive proposals been available the provisions would have been the same.

8.2.3.7 Canada

In the Canadian legal system[591], some cities and municipalities have regularised necessary and proportionate measures[592] as a way of addressing the several increasing effects of light pollution.[593] Problems following excessive or obtrusive light in the wrong place at the wrong time in urban brightness areas and dark-sky conservation landscapes[594] have been addressed to discuss the needs of municipal regulatory mechanisms which have been recently introduced by Canadian professional

[591] Mississippi Mills Residents' Association, *Keeping the Stars in the Skies in Mississippi Mills*, available from http://www.mmra.ca/archives/2004-03-24_Light_Pollution_brochure_web.pdf accessed 25 September 2014.
[592] Municipal District of Foothills, *MD of Foothills No. 31 Dark Sky Bylaw*, Municipal District of Foothills, 2011, pp 1-23.
[593] Law Reform Commission of Saskatchewan, *Background Paper: Light Pollution Abatement Legislation*, available from http://lawreformcommission.sk.ca/LightPollutionAbatementBP.pdf accessed 25 September 2014.
[594] West Coast Environmental Law, *By-Laws and Policies: Dark-Sky*, available from http://wcel.org/laws-and-policies accessed 25 September 2014.

astronomical and environmental bodies. For example, the Royal Astronomical Society of Canada (RASC)[595] has taken several good examples of Italian regional light pollution laws that established unique legal mechanisms that emerged recently, where expansion of urban brightness areas from uncontrolled floodlight installations and design, the result of emitting excessive or obtrusive light at night in urban areas, was widespread in Italian large urban sites. The RASC's stakeholders are concerned not only with specific regulatory approaches[596] but with introducing to useful incentive mechanisms that take the form of managing the preventive performance in Canadian municipalities through the use of a campaign programme, such as the *RASC Light Pollution Abatement Programme*, that aims to reduce inappropriate levels of light pollution in urban district brightness areas and dark-sky conservation landscapes by advising Federal, Provincial and Municipal governments and agencies along with private sectors and concerned Canadian people to take action to tackle key aspects of light pollution. Whilst many astronomical bodies have used the RASC programme to prevent non-legally binding activities, some Canadian municipalities have officially delegated their legislative authorities to adopt aspects of the *RASC programme* and set out their own written legally binding rules to ensure that the aims of light pollution control are implemented and enforced. Therefore, the *RASC programme* comes into force in some Canadian municipalities. It certainly sets appropriate uses of light in important illuminating engineering and architectural lighting areas[597], mostly relating to light standards and lighting quality. As this is a RASC's guidance for light pollution control, intended to simplify and clarify certain rules across all municipalities in Canadian legal system, many Canadian municipalities do not have much flexibility on how they should adapt necessary aspects of the *RASC programme* into municipal law in their own municipal jurisdictions.

A widespread urban light pollution problem is the atmospheric orange brightness smog

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[595] Royal Astronomical Society of Canada, *Environmental Impact of Light Pollution and its Abatement*, Royal Astronomical Society of Canada, 2012, p 23.

[596] RASC Vancouver Centre, *Recommendations*, available from http://rasc-vancouver.com/lpa/files/2011/02/RECOMMENDATIONS.pdf accessed 25 September 2014.

[597] City of Kitchener, *Urban Design Manual – Part C: Design Standards C-1 Urban Design Manual*, City of Kitchener, 2010, p 11.

that extends over much of Canada's provinces and territories, with both urban lighting activities and light energy use often inefficient.[598] Currently, Canadian regulatory lighting practices can provide effective mitigation of emissions of excessive or obtrusive light from outdoor lights.[599] A wide range of full-cut-off fixtures, minimum lighting level used for safety, environmentally-effective illuminating engineering technologies and recommended values for average surface illumination[600] are available to mitigate emissions and provide light energy efficiency[601], healthy night environmental protection and sustainable lighting benefits.[602] For example, the principles of astronomical and environmental light pollution protection led to some Ontario municipalities' efforts to devise local lighting standards for both astronomical observatory and healthy environment purposes to govern the outdoor lighting activities of individuals and public sectors. Two significant jurisdictions in Ontario, such as the town of North-eastern Manitoulin and the islands and the town of Richmond Hill, have been at the forefront, establishing municipal elements of environmentally friendly lighting practices that apply to both astronomical light pollution and ecological light pollution. Both jurisdictions provide for necessary and proportionate regulatory measures to carry out to high environmental standards, through the application of environmentally friendly levels of outdoor lighting at night, where necessary or appropriate under the *Corporation of the Town of North-eastern Manitoulin and the Islands By-Law*[603] and the *Town of Richmond Hill's Light Pollution By-law*.[604]

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[598] Dick, R. and Weeks, A., 'Fighting Light Pollution in the Ottawa Area - The Results', *Journal of the Royal Astronomical Society of Canada*, 1997 66 (4), pp 1-12.

[599] Dick, R., *Lastovo - 2010 Dark Sky Preserve Program in Canada*, RASC Light Pollution Abatement Program, 2010, pp 1-8.

[600] Mississippi Mills Residents' Association, *Preservation of Our Night Sky*, available from http://www.mississippimills.ca/en/live/resources/Illuminationby-lawandinformation.pdf accessed 25 September 2014.

[601] Federation of Canadian Municipalities, *Green Municipal Fund - Energy Bylaws*, available from http://www.fcm.ca/home/programs/green-municipal-fund/resources/energy-resources/energy-bylaws.htm accessed 25 September 2014.

[602] Royal Astronomical Society of Canada, *RASC Light Pollution Abatement Program*, Royal Astronomical Society of Canada, 1988, pp 1-22.

[603] Municipality of Northeastern Manitoulin and the Islands, *The Corporation of the Town of Northeastern Manitoulin and the Islands By-Law No. 2009-16: Being a by-law to enact a policy to regulate outdoor lighting and in support of the National Dark Sky Sanctuary Designation*, available from

Furthermore, the Canadian legal system also addresses light pollution problems in urban planning regimes. For reasons of reducing risk from dark-sky environment changes by placing control over urban planning development in lighting areas or keeping the numbers of efficient light fixtures and the sites for such sustainable lighting design to a proportion consistent with the urban environmental zoning for outdoor lighting control. For example, the District of Saanich, a local authority of British Columbia established the *District of Saanich's Municipal Outdoor Lighting Standards for the Control of Light Pollution of 2006* and the *District of Saanich's Zoning Bylaw of 2003*[605] that permit the District of Saanich municipality to play the primary role in establishing urban development standards for good outdoor lighting practices. These bylaws ensure an integrated approach to considering good municipal lighting practices, location of urban outdoor lighting facilities and discretionary planning application. This means environmentally friendly or appropriate light fixtures and design will have to be passed for development and refurbishment to be allocated or permitted under a couple of the District of Saanich's frameworks. Local planning authorities of the District of Saanich must enhance environmentally friendly lighting either integrally or jointly by applying planning regulatory standards when determining planning applications.

This *RASC programme* may be positively supported in that the RASC's guidance might create non-legally binding standards as Canadian municipalities with shared issues of outdoor lighting may have advantages when establishing night or dark-sky environment protection across municipalities. This means that all Canadian municipal light pollution requirements will be harmonised by the *RASC programme* to provide environmentally friendly outdoor lighting at a municipal level, for example, nothing will be different when aspects of the *RASC programme* are extended to the urban development of municipal lighting facilities towards trans-municipal lighting facility linkages (i.e. requirements that brings together Canadian municipalities with the basic objective of promoting cooperative efforts to protect their shared municipal dark-sky atmosphere or

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http://www.townofnemi.on.ca/sites/default/files/DarkSky.pdf accessed 25 September 2014.

[604] Town of Richmond Hill Council, *Light Pollution By-law*, available from http://www.richmondhill.ca/subpage.asp?pageid=pd_light_pollution_bylaw accessed 25 September 2014.

[605] District of Saanich, *Corporation of the District of Saanich Bylaw No. 8789 to Regulate Signs*, available from http://www.saanich.ca/living/pdf/sign8789.pdf accessed 25 September 2014.

shared municipal lighting facilities).

However, while outdoor lighting requirements have an important role to play in increasing practical efficiency of light pollution control and have facilitated best practice of outdoor lighting in some Canadian municipalities, the *RASC programme* was not acknowledged by the majority of Canadian municipal jurisdictions because the *RASC programme* merely presents a non-legally binding framework for the implementation of existing technical outdoor lighting standards for light pollution control. It could be argued that a lack of uniformity in the legal lighting practices of Canadian municipalities at national level and an inadequacy of national legal obligations or mechanisms, in the approach to the light pollution requirements are the most significant barrier to harmonised light pollution control in the Canadian legal system.

8.2.2.8 United States

Whilst the U.S. legal system is an example of the significant influence of a traditional common law system on the light pollution laws introduced a wide range of measures to tackle light pollution as mentioned above, a range of benefits from written regulatory frameworks (i.e. U.S. soft law and U.S. hard law) are expected for both astronomical and environmental interests[606] where the Federal dark-sky environment[607] is prevented from providing light pollution prevention.[608] In relation to light pollution prevention at all American level which has not been protected by U.S. Federal case law[609], the certain written law is extremely useful for Federal Government, State Governments, and

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[606] Monrad, C. K., Benya, J., and Crawford, D. L., *Rosemont Copper Project: Light Pollution Mitigation Recommendation Report*, Monrad Engineering INC, 2014, p 2.

[607] Davis, S., *Light Pollution*, available from http://yosemite.epa.gov/sab/sabproduct.nsf/CD5C8191E82D937D8525741F006252FD/$File/Attachment+to+Comments+from+Stephen+Davis+EPEC+4-9-08.pdf accessed 26 September 2014.

[608] Richkus, P. N. et al, *Task Force to Study Lighting Efficiency & Light Pollution in Maryland*, Maryland's State Archives, 2002, pp 1-63.

[609] While light pollution is the subject of municipal laws, state laws, and national dark-sky conservation plans, the U.S. Federal environmental and planning laws do not specially aim at achieving all aspects of light pollution prevention, striking the right balance between lighting energy consumption and environmental protection at U.S. Federal level. See Nagel, J. C., 'The Idea of Pollution', *University of California Davis Law Review*, 2009 43 (1), pp 1-78.

municipal authorities who have not had established their provisions because of a lack of importance of certain written frameworks or for other reasons. For example, for a while it was possible to attempt to argue the U.S. legal system was unclear or at least inconsistent with existing rules and uncertain light pollution harms, which have to allow those rules to prevent all forms of risks from light pollution. This research, therefore, argues that there is a significant need to analyse when such national, State, and municipal light pollution legislation is required. This subheading looks at these legal problems with the assistance of dual-concern analysis of American light pollution studies. The first critically concerns the national harmonised regulatory framework with respect to which the previous American model law (i.e. *Joint IDA - IES Model Lighting Ordinance - MLO*) may underline the minimum standards for light fixtures, design as well as practices. The second critically concerns how the U.S. national light pollution law may adopt all aspects of light pollution control which demonstrates the all the necessary or proportionate requirements to promote sustainable lighting practices at all U.S levels.

8.2.2.8.1 U.S. national light pollution law

At national level, U.S. light pollution law consists of a body of rules governing the decisions in previous light pollution cases, harmonised standards on illuminating engineering or architectural lighting design in relation to dark-sky preservation, as well as other relevant aspects. [610] It traditionally comes from various sources of soft law.[611]

At present, U.S. soft law instruments as attractive alternatives to sustainable lighting practices, are covered by two sets of soft laws. One, the *Joint IDA - IES Model Lighting Ordinance* or *MLO* as a unique U.S. soft law consists of a set of rules[612] governing the

[610] Bailey, D., et al, *Harbouring Pollution: Strategies to Clean Up U.S. Ports*, Natural Resources Defense Council, 2004, p 16.

[611] The development of illuminating engineering technology and architectural lighting design technique has opened a promising new chapter in the modern history of urban night society. However, while astronomical and environmental light pollution exploitation of the U.S. Environmental Protection Agency (EPA) has grown exponentially in recent years, the trend of U.S. Federal light pollution hard law and U.S. Federal light pollution case law has so far not been followed by the U.S. legal system. See Berthaume, T., *Light pollution: a case for federal regulation*, PhD Thesis, Rochester Institute of Technology, 2007, p 49.

[612] Illuminating Engineering Society of North America and International Dark-Sky Association, *Joint*

harmonised standards on lighting levels, lighting sources as well as lighting practices.[613] The *MLO* is aimed at U.S. State Governments and U.S. Municipal Governments in Northern America.[614] Even though it is not legally binding, it gives them non-legally binding views on how they should make of State and local jurisdictions responsible for the implementation[615] of all aspects of light pollution control under the model law's requirements. The *MLO* provides new standards for light fixtures and design of public buildings, commercial buildings, and residential buildings by mandating that outdoor or exterior lights of these buildings be installed to a specific minimum standard for light pollution prevention.[616] Under *MLO*'s mandates at national level, new light fixtures and design will more effectively use local sources or municipal outdoor lights at night and be installed with more efficient sources of lights and sustainable lighting practices than previous premises.[617] Two, the *Leadership in Energy and Environmental Design* or the *LEED standards of the U.S. Green Building Council*, as a national set of rating systems for green building[618] in relation to light pollution control[619], is concerned with light pollution control standard through rating green building scores[620] where *LEED*-approved green buildings[621] are constructed or refurbished to a specific outdoor lighting

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IDA-IES Model Lighting Ordinance (MLO), Illuminating Engineering Society of North America and International Dark-Sky Association, 2011, pp 1-44.

[613] International Dark-Sky Association, *Model Lighting Ordinance Released to Promote Responsible Outdoor Lighting*, available from http://www.darksky.org/assets/documents/MLO/MLO_PR.pdf accessed 26 September 2014.

[614] State of New Jersey, *Outdoor Lighting Ordinance Guide*, State of New Jersey, 2006, pp 1-17.

[615] Illinois Coalition for Responsible Outdoor Lighting, *Outdoor Lighting Ordinances: Proven Alternatives to the "M.L.O."*, available from http://www.illinoislighting.org/resources/ICROL-Lighting_Ordinances.pdf accessed 26 September 2014.

[616] Pennsylvania Outdoor Lighting Council, *Model Outdoor Lighting Ordinance for Use as A Stand-Alone Code*, Pennsylvania Outdoor Lighting Council, 2014, pp 1-9.

[617] Horner, P. and Horner, B., *Session 4: Federal and State Legislation*, available from http://www.lrc.rpi.edu/education/outreacheducation/pdf/CLE4/AM_FedStateLegislation.pdf accessed 26 September 2014.

[618] U.S. Green Building Council, *LEED 2009 for New Construction and Major Renovations*, U.S. Green Building Council, 2008, p 5.

[619] Jouaneh, M., *LEED NC 2009 and Light Controls*, Lutron Electronics Co., Inc., 2011, pp1-9.

[620] Koninklijke Philips Electronics N.V., *Lighting for LEED Application guide for sustainable offices*, Koninklijke Philips Electronics N.V., 2012, pp 1-19.

[621] Green Building in Pennsylvania and Governor's Green Government Council, *What is Green Building?: Fundamental Principles of Green Building and Sustainable Site Design*, available from http://www.epa.gov/statelocalclimate/documents/pdf/12_8_what_is_green_GGGC.pdf accessed 26

standard.[622] The two systems are slightly different; although they both address the same outdoor lighting practices, they use different soft law concepts and lead to different outcomes.

To critically assess U.S. soft law based on a set of aspects relating to the strengths and weaknesses of the current U.S. soft law instruments established by the *MLO* and *LEED* requirements and to provide answers to these legal issues the evaluation examined the current strengths and weaknesses of the existing U.S. national light pollution frameworks further critical analysis of stakeholders of U.S. national light pollution prevention on how best to use the existing soft law and national light pollution awareness raising is needed by this subheading' critical review.

In strengths of both *MLO* and *LEED* soft laws, stakeholders (for example, the general public, businesses, industries, commercial retailers, and the public sector) would have a number of selective choices. They are able to bring a more sustainable outdoor illumination by incorporating the *MLO*'s outdoor lighting standards and the *LEED*'s green building rating requirements into the light installation and design of outdoor light premise that minimise short-term and long-term negative impacts on the dark-sky environment. This would also enable them to incorporate the *MLO* and *LEED* techniques into municipal outdoor lighting practices, for example, the U.S. localities or municipalities can adopt useful techniques of light pollution control for new outdoor light developments for the benefit of light pollution control. Alternatively, the U.S. Central Government might use the *MLO* or *LEED* soft law, on the basis that the light pollution has been officially defined, by allowing for the adoption of new light pollution control standards within the U.S. national regulatory framework.

This research argues that, for reasons of consistency with the different perspective purposes of the *MLO* and *LEED* requirements under non-legally binding law at national level, there is large variation both in the different ways the *MLO* dark-sky aims to set municipal light pollution control standards and, more particularly, in all the aspects of

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September 2014.

[622] U.S. Green Building Council, *Pilot Credit 7: Light Pollution Reduction*, U.S. Green Building Council, 2012, pp 1-9.

LEED green building rating system in relation to harmonised environmental and energy scoring assessment which green building stakeholders will incur in using the specific means of light pollution control for energy saving reputation and which sets the minimum requirements for achieving green building certification. The *MLO*'s aspects are, on the other hand, used to set any standards based on all circumstances or situations of the dark-sky protective approaches, and are able to include all basic aspects of municipal dark-sky aims at local level.

Likewise, there could be challenges on the basis that both of the *MLO* and *LEED* are also considered for environmentally friendly scenarios that the U.S. soft law enhances light stakeholders' ability to choose effectively between different *MLO* standards and *LEED* requirements for targets in their light pollution control plans. As all light stakeholders have no compulsory obligation to adopt in all aspects of existing soft law other than their own optional decisions at national level, and in order to create a national level of light pollution control within U.S. jurisdiction, the certain substantive law of light pollution control should also apply when light pollution has become the U.S. environmental health risk at national level as will be further mentioned hereafter in Chapter 9.

One critical question that might need to be asked is what will happen to the current law without setting hard law or legally binding requirements at U.S. national level. Whilst there is no set of national light pollution laws, and almost nothing is to be establish from the U.S. national hard law, the U.S. legal system set a range of recognising the benefits of new land development projects or redevelopment projects through *LEED*'s light pollution prevention doctrines. The U.S. Government has recently established many pieces of national legislation[623], for example, the *Energy Efficiency Modernization Act 2009*, the *Expanding Building Efficiency Incentives Act 2009*, the *Energy Efficiency in Housing Act 2009* and the *Better Buildings Act of 2014* which specifically set out the Government response to the guidance by the U.S. Green Building Governing

[623] Park, E., 'The U.S. Federal Green Building Policy', *Sustainable Development Law & Policy*, 2007 1 (8), p 71.

Stakeholders on green building proposals for national green building standardisation.[624] These U.S. regulatory frameworks were designed to fill some of the gaps left by non-legally binding *LEED* requirements. It is not primarily a single national light pollution law, but it applies to U.S. energy problems[625] arising from unnecessary light or non-environmentally friendly light at night at national level. These U.S. green building laws come into force in all U.S. States and aim to clarify national green building rules in certain important areas, mostly relating to increasing energy efficiency in buildings and reducing energy consumption.

Despite the high standards of green building exhibited by the American green building law, there are a range of effects of energy-related light pollution that have not been identified specifically. In order to qualify as a critical review of light pollution law, this subheading has to be helpful in obtaining an analysis of the subject matter in reform the future law. The U.S. law scholars from the Columbia Law School's Sabin Centre for Climate Change Law (CCCL) conducted a study on the *Model Municipal Green Building Ordinance (MMGBO).*[626] This study reveals that a number of doctrines under the model law guarantee a high level of municipal green building standardisation at national level. It strongly recommends that municipal green buildings should meet acceptable or proportionate lighting standards of the *LEED*'s light pollution prevention aspects because this model law is intended to aid municipalities in developing or modifying *LEED*'s lighting criteria under the municipal green building law.[627] Some States and municipalities have enacted their own written green building laws, but for various reasons for harmonising municipal light pollution control at U.S. national level as further discussed below, a municipality might need to examine its written law and

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[624] U.S. Environmental Protection Agency, *Federal Green Building Requirements*, available from http://www.epa.gov/oaintrnt/projects/requirements.htm accessed 26 September 2014.

[625] U.S. Department of Defense, *Unified Facilities Criteria (UFC): High Performance and Sustainable Building Requirements, U.S. Department of Defense*, 2014, p 7.

[626] Columbia Law School Sabin Center for Climate Change Law, *Model Municipal Green Building Ordinance*, available from http://web.law.columbia.edu/climate-change/resources/model-ordinances/model-municipal-green-building-ordinance accessed 26 September 2014.

[627] Sussman, M. and James, J., *Model Municipal Green Building Ordinance*, Center for Climate Change Law at Columbia Law School, 2010, pp 1-2.

make revisions[628] if the U.S. Municipal Government agrees with the *Model Municipal Green Building Ordinance* that lighting standards for green building's light pollution prevention should be available.[629] The concepts of this model law are equally divided between action based on *LEED* rating system requirements for new constructions and major renovations and action based on the following incentives designed to encourage the use of *LEED*'s standards for light pollution prevention in every municipal jurisdictions across U.S. country. For example, it may give rise to national effective consequences if all U.S. localities or municipalities adopt fully as a result of the fulfilment of enforcement action taken against light pollution through meeting compulsory requirements of light pollution prevention at LEED Silver rating level.

Columbia Law School's *MMGBO* research paper[630] on the setting of good lighting practices for municipal green buildings has a main point of critical criticism of national harmonised light pollution prevention and noted that there were some issues of adoption or implementation by U.S. municipal authorities. This research paper can be argued that this is inadequate of harmonising national light pollution control since it is only for the U.S. localities and municipalities to adopt concepts of the *MMGBO* whether, on the basis of the U.S. model law for harmonising national municipal standards, they are their own alternative choices of adoption and whether they are likely to be able to select the following concepts of model law themselves.[631] This means that model law merely represents a range of non-legally binding examples of good lighting practices from the *MMBBO* through the offers for alternative choices[632] of municipal law making, relevant

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[628] James, J., *Legal Analysis of Model Municipal Green Building Ordinance*, Center for Climate Change Law at Columbia Law School, 2010, pp 1-22.

[629] Gerrand, M. B. and James,J., *Model Green Building Ordinance Proposed for Adoption by New York Municipalities*, available from http://web.law.columbia.edu/sites/default/files/microsites/climate-change/files/Resources/Model-Ordinances/Model-Green-Building/GerrardModelGreenBuilding.pdf accessed 26 September 2014.

[630] Wolf, M. A., 'A Yellow Light for "Green Zoning": Some Words of Caution About Incorporating Green Building Standards into Local Land Use Law', *Urban Lawyer*, 2011 4 (43), pp 949-975.

[631] Brown, E. G., *State and Local Government Green Building Ordinances in California*, State of California Department of Justice, available from http://ag.ca.gov/globalwarming/pdf/green_building.pdf accessed 26 September 2014.

[632] U.S. Environmental Protection Agency, *Tribal Green Building Codes: Existing Green Building Codes*, available from http://www.epa.gov/region9/greenbuilding/codes/existing.html accessed 26 September 2014.

public concerns of local or municipal light pollution problems. Again, the U.S. municipal jurisdictions, hereinafter referred to as concepts of model law, adopted by the regulators or law makers, expressing their wish to resort in all matters of municipal green building concerning them in respect of any astronomical and environmental light pollution problems arising in application of the model law's concepts to the compulsory jurisdictions of the U.S. localities or municipalities, unless some other forms of light pollution has been provided by the model law in relation to *LEED* light pollution prevention. A single example might be adoption of the *Town of New Castle's Local Law Enacting a Green Building Law 2011*[633] that is based on the *Model Municipal Green Building Ordinance*, taken by the Town of New Castle authority in New York and requesting enforcement of the *LEED*'s green building concepts for light pollution prevention by the requested authority. However, there are no other U.S. municipalities or localities which support the concepts of *LEED*'s light pollution prevention and apply necessary or proportionate principles in their own regulatory provisions.

To conclude, at U.S. national level, national legally binding law for light pollution prevention have not been officially recognised in U.S. national jurisdiction although some non-legally obligations have been established in non-legally binding professional guidance from by lighting governing bodies, for example, the *MLO*, the *LEED* and the *MMBBO*, as mentioned above. Influences of soft or non-legally binding, law can be found in the U.S. legal system as included in our studies above. The U.S. jurisdiction may offer various forms of the light pollution frameworks since this is a legal regime which – though in many respects influenced by elements of U.S. soft law and U.S. model law – has, on this point, opted for what we have referred to above, the standardisation of harmonised light pollution control at U.S. national level.

To analyse the different roles that U.S model law (for example, the Columbia Law School's *Model Municipal Green Building Ordinance* and the *Joint IDA - IES Model Lighting Ordinance*) and the comparative methods of municipal law approaches

[633] New York Town of New Castle, *A Local Law Enacting a Green Building Law*, available from http://web.law.columbia.edu/sites/default/files/microsites/climate-change/files/Resources/Model-Ordinances/Model-Green-Building/New%20Castle%20Town%20Board%20Law.pdf accessed 26 September 2014.

currently play in the control of light pollution control in different U.S. municipal jurisdictions, we will look into whether municipal law studies create an academic analysis as distinguished from a critical review of the existing U.S. municipal light pollution law as discussed below.

8.2.2.8.2 U.S. State light pollution law

U.S. State light pollution law is traditionally divided into two branches of U.S. State light pollution law, case law relating to appropriate or unnecessary lighting, and soft law. Firstly, light nuisance in U.S. common law jurisdiction is a broad term used to describe the nuisance matters of excessive or obtrusive lights that make many neighbour's lives a misadventure from intrusiveness of lights to irritating and disturbing the neighbours. The U.S. legal system has considered a number of interesting cases in areas of light nuisance over the last few decades. For example, the California State case of *City of Chula Vista v. California Coastal Commission*, 183 Cal. Rptr. 909, 921-22 (Cal. Ct. App. 1982)[634] contains a necessary elements of light pollution underlying the contexts of U.S. light pollution definition. This U.S. common law case considers intrusiveness of lights not only causes light pollution but also impacts on the conservation of species by affecting the migratory birds. [635] Here the U.S. Court agreed that floodlighting from a development might disrupt the ecological pattern of light and dark which is likely to affect the smallest tern bird species. Despite a series of decisions by U.S. State judges, there has been legislative change. This is because some U.S. States and municipalities have sought to justify the regulatory frameworks. They have adopted many rules of light pollution control set out in the State or Municipal written legislation (i.e. the soft law implementation frameworks and the self regulated frameworks) that are appropriate for various aspects of modern light pollution. However, this research argues that some U.S. State case laws, where the use of precedent is the unique basis of the common law system under the principle of classical

[634] Justia Premium Legal Marketing Services, *City of Chula Vista v. Superior Court (Cal. Coastal Comm.) (1982)*, available from http://law.justia.com/cases/california/court-of-appeal/3d/133/472.html accessed 25 September 2014.

[635] Ploetz, K. M., 'Light Pollution in the United States: An Overview of the Inadequacies of the Common Law and State and Local Regulation' *New England Law Review*, 2002 (36), pp 985-1039.

stare decisis are not best dealt with for all matters of light pollution, rather than by establishing certain written rules which can be used as a new basis of light pollution protection.[636] Also, uncertain discretion of the U.S. State courts does not make a certain degree of lighting require for healthy night environment, sometimes for reasons of lack of sufficient light pollution concerns, but often through poor unwritten common law. The U.S. State courts have never identified sufficient alternative forms of assistance to justify the level of lighting, which might be complemented by written statutory reforms to the lighting standards through certain written levels or degrees of environmentally friendly lighting mentioned above, might help to ensure that light pollution cases are brought certainly and measurably to U.S. justice. Problems of uncertainty of precedents in the U.S. State common law might be extremely difficult for the illuminating engineers, lighting design architects and lawyers concerned in the last few decades, particularly where an area of U.S. State light pollution law had been excluded because it was considered insufficiently important to require a stricter control regime, because there were alternative resolutions of preventing risks for the healthy dark-sky environment, or because classification into various degrees of non-environmentally friendly lighting was based on the previous system of U.S. State case law for the classification of harmful degrees of artificial light nuisances, which did not ensure the astronomical or environmental application of similar precedential levels of light pollution control across an U.S. State jurisdiction.

Secondly, U.S. model law, which is established by professional lighting bodies, not only aims at enhancing the standardisation of U.S. national harmonised light pollution law in localities and municipalities of the main issues in the key forms of light pollution, and at raising awareness of the need to develop their light pollution provisions, but also

[636] Uncertainties in legal outcomes from criteria of common law judge decides under the principle of *stare decisis* that result from imperfections in fact-finding of illuminating engineering technologies and architectural lighting techniques are therefore treated identically to those that result from indeterminacies in the legal obligation that the agent faces. This research argued the principle of U.S. common law's *stare decisis* that the economic loss claimed were not recoverable, as they could only be classified as pure economic loss, not consequential upon being any prejudicial to someone's health. It further argued that, under the *stare decisis* rule, people might not recover for economic loss resulting from intrusive or obtrusive lights shine to property which was theirs. See Kornhauser, L. A., 'An Economic Perspective on Stare Decisis', *Chicago-Kent Law Review*, 1989 1 (65), pp 63-92.

strongly influences the U.S. State legislatures to evaluate environmental health risks and bring the adoption of new legal aspects of light pollution control from the U.S. model law, if necessary or proportionate.[637] While the adoption of U.S. State light pollution law is a part of a guarantee that it will indeed affect outdoor light uses, or that it will affect energy consumption at U.S. State level[638], the lack of uniformity of national light pollution legislation in the standardisation of the national measures, in the harmonisation of all U.S. levels available is a significant barrier to requiring all U.S. States to approach light pollution prevention in State stage processes.[639] This subheading underpins a critical review of the existing U.S State regulatory frameworks. It is for the comparative study of U.S State light pollution law for light pollution control purposes, particularly, to compare and contrast different aspects of the U.S. State light pollution legislation that all of its provisions have an important role to play in reforming the future English light pollution provisions. However, this subheading also has a number of critical arguments that show that there are various different factors between the U.S. State laws and other contexts of light pollution control at State level, for example, legal systems of U.S. State, geography, demographics, and transportation.

To review the effectiveness of many samples of light pollution law, to assess the implications of existing approaches and to consider how to enhance legislative enforcement in future light pollution prevention at U.S. State level, this research seeks to critically discuss a range of impacts of existing U.S. States' regulatory frameworks. Currently, there are several special targets for light pollution control and stage processes identified in the U.S. State law. These are light from three main forms of non-environmentally friendly lights (i.e. sky glow, glare, and intrusiveness of lights), promotion of energy-efficient lighting within the U.S. State, conservation of species

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[637] Elliot, D. and Mowery, M., *Using Outdoor Lighting Ordinances to Mitigate The Unwanted Effects of Light Pollution*, MRSC of Washington, 2006, pp 11-13.

[638] There are some specific laws within some U.S. State jurisdictions that require incorporated municipalities to maintain the lights on outdoor lighting facilities, but many incidents of exterior light pollution at night are not caused by occurrences of defective outdoor lights at night. See Champa, J., *Highway Lighting Practices and Policies*, Preliminary Investigation Caltrans Division of Research and Innovation, 2013, p 12.

[639] U.S. Department of Energy, *Exterior Lighting Guide for Federal Agencies*, U.S. Department of Energy & Department of Energy's Federal Management Program, 2010, p 48.

living in ecological areas, and environmental areas for outdoor lighting control within planning developments. However, some of the U.S. State light pollution laws do not adequately address all necessary stage processes or proportionate protective measures and some of the U.S. State light pollution laws do not clearly state all aspects of lighting requirements of outdoor light at night.

With this point in mind, when we critically discuss many aspects of the U.S. State light pollution law that has launched legal proceedings against excessive levels and obtrusive use of lights at night, we must necessarily draw on historical sources to evaluate the contribution the U.S. State Governments have made to creating current U.S. States' light pollution laws.

Firstly, as described in previous subheadings of the model law guide on U.S State light pollution law reforms, in response, alternatively following implementation of the U.S model laws (i.e. the *MLO*, the *LEED* and the *MMGBO*), more U.S. State jurisdictions got necessary or proportionate measures from adopting reflective approaches to the subject of the U.S. model laws. As described above, in response to technical points made by the U.S. model laws, the U.S. State Governments would include the following key elements of outdoor lighting practices and provide harmonisation benefits from various basic principles as to how dark-sky or environmental quality should be assessed and managed in the U.S. State through direct regulation of the U.S. State legal systems that are intended to improve the level of environmentally friendly lighting practices that are available at U.S. State level. For example, the *U.S. Green Building Council's LEED* energy efficiency in relation to green building design and environmental lighting problems also set out the general minimum standard of light pollution protection. Any State Government can enact necessary or proportionate legal aspects of *LEED*'s green building requirements that are more protective or prospective, for example, the *Maryland's High Performance Buildings Act of 2008* means a green building that achieves at least a silver rating for new construction and major renovation building projects, according to the U.S. Green Building Council's *LEED*. Consequently, compulsory measures will also give rise to intended approaches for light pollution control if the enforcement of compulsory Maryland State's *LEED*'s green building

rating systems emerges, fully as a result enforcement action taken against non-environmentally friendly or inefficient outdoor lighting.

Secondly, while many in the U.S. State jurisdictions have contributed to improving the implementation of the *MLO*, the *LEED* and the *MMGBO* and coordination with implementation of other aspect of professional lighting bodies' standards or astronomical bodies' requirements as discussed above, legislators in some U.S. State Governments have defined the specific U.S. State's measures as consistent and conforming to their special light pollution problems themselves. For example, Florida State's regulatory protection for endangered turtle species[640], through more effective enforcement of the *Florida's* the *Model Sea Turtle Friendly Lighting Ordinance 1993*[641] and other *regulatory resources in Florida sea turtle*[642] *lighting*, is currently provided in coastal brightness areas in Florida State jurisdiction.[643] The Florida State Government particularly focuses on responding to some specific loss of sea turtles due to key forms of ecological light pollution at night[644] and delivering ad hoc regulatory lighting requirements for Florida State's urban coastal areas.[645] The Florida legislators can address some special regulatory measures in terms of enforcement of Florida State's environmental and planning laws. They are particularly appropriate for outdoor lighting

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[640] U.S. Fish and Wildlife Service, *Hawksbill Sea Turtle - Eretmochelys imbricata*, available from http://www.fws.gov/verobeach/msrppdfs/hawksbillseaturtle.pdf accessed 27 September 2014.

[641] University of Florida's Levin College of Law, *The Sea Turtle Friendly Lighting Initiative*, available from http://www.law.ufl.edu/_pdf/academics/clinics/conservation-clinic/Legal_and_Biological_Introduction.pdf accessed 27 September 2014.

[642] Florida Fish and Wildlife Conservation Commission, *Marine Turtles and Lights*, available from http://myfwc.com/wildlifehabitats/managed/sea-turtles/turtles-lights/ accessed 27 September 2014.

[643] Barshel, N. et al., *Sea Turtle Friendly Lighting*, University of Florida's Levin College of Law, 2014. p 2.

[644] Light pollution can misdirect Florida's migrating turtle species. Atmospheric sky glow at coastal brightness landscapes generally misdirect Florida's sea turtle hatchlings into land instead of out to sea by outshining the moon. The consequences of incidents of light pollution lead the effects on sea turtle nesting density, hatchling disorientation, and hatchling mortality. See Kamrowski, R. L., Limpus, C., Moloney, J. and Hamann, M., 'Coastal light pollution and marine turtles: assessing the magnitude of the problem', *Endangered Species Research*, 2012 19 (85), pp 85-98. and see further Magyar, T., *The impact of artificial lights and anthropogenic noise on Loggerheads (Caretta caretta) and GreenTurtles (Chelonia mydas), assessed at index nesting beaches in Turkey and Mexico*, PhD Thesis, Universität Bonn, 2008, p 10.

[645] Shudes, K., *Addressing Florida's Beachfront Lighting Problem*, available from http://www.conserveturtles.org/velador.php?page=velart97 accessed 27 September 2014.

requirements where turtles from a broad range of urban costal brightness areas and coastal ecological intrinsic landscapes will need to be involved.[646] As some U.S. State jurisdictions develop their light pollution control measures, the special U.S. State model law is vital to ensuring the best practices for specific light pollution problems at U.S. State level. Consequently, the benefits of using specific measures at U.S. State level must particularly be balanced with the need to protect unacceptable risk to nocturnal wildlife or the night environment and the need to identify priority areas for specific action, geographic variations and manage different environmental risks from significant types of light pollution where possible.

Thirdly, while the U.S. State law and regulatory resource both require that a release is managed to ensure there is not a series of light pollution risks that have the potential to cause harm to ecological habits, human health or the night environment in some U.S. States, a number of U.S. States nevertheless do not have sufficient regulatory resources (i.e. soft law and hard law) to ensure that urban district areas and the dark-sky environment are stringently protected. The lack of availability of the standardising of U.S. State legal instruments would have a great impact on outdoor lighting practices and make them difficult to prevent key aspects of light pollution at night in a number of U.S. States. As some U.S. State laws apply to especially identifiable general or special light pollution measures contained in U.S. States' regulatory frameworks in some U.S. State jurisdictions, this means that necessary or proportionate measures are generally not applicable to many U.S. States where environmental and planning problems in relation to outdoor light uses have not been identified by U.S. States' officials or agencies.

As discussed in earlier paragraphs, the application of U.S. State light pollution control means that the awareness of the risk factors associated with U.S State's outdoor lighting activities and other relevant factors (i.e. geography, demographics, and economy) can change over time as new illuminating engineering technologies or architectural lighting design techniques are developed, and the U.S. States' measures of existing outdoor

[646] Florida Atlantic University, *Light Pollution Hurts Reptiles in the Environment*, available from http://physics.fau.edu/observatory/lightpol-Reptiles.html accessed 27 September 2014.

lighting practices vary. Nowadays, there are several forms of U.S. municipal light pollution laws to be gained from effective responding which can help to tackle the main aspects of light pollution[647], for example, the *Arizona State's House Bill Title 49 (Chapter 7)*[648], the *Michigan State's Natural Resources and Environmental Protection Act of 1994*[649], the *Minnesota State's Outdoor Lighting Fixtures Model Ordinance of 2008*[650] and the *New Mexico State's Night Sky Protection Act of 1999*[651]. As awareness of light pollution problems has grown and national interest groups have become more concerned about risk to human health or the night environment, so demands of the U.S. State regulatory requirements have increased for more and better engagement in legislative decision-making. However, a serious weakness with this viewpoint of U.S. State light pollution control is a lack of several types of environmental incentives that are generally used or applied more widely. They may affect the gaining of an awareness of improving quality of the dark-sky environment at night as a result of the light pollution prevention; either through market-based economic incentives adopted or by innovatively discovered new regulatory mechanisms.

8.2.2.8.3 U.S. municipal light pollution law

As we have previously mentioned in connection with the U.S. State legal system, the scope of the U.S. written municipal law is able to be influenced by U.S. State legislative requirements and U.S. State environmental boundaries. Certain written rules for

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[647] International Dark-Sky Association, *Directory of Lighting Ordinances*, available from http://www.darksky.org/outdoorlighting/35-ida/outdoor-lighting/81-other-ordinances accessed 27 September 2014.

[648] Arizona State Legislature, *Title 49 - The Environment*, available from http://www.azleg.state.az.us/ArizonaRevisedStatutes.asp?Title=49 accessed 27 September 2014.

[649] State of Michigan Legislative Council, *Natural Resources and Environmental Protection Act (Excerpt) 324.75101*, available from http://www.legislature.mi.gov/(S(x0kvea552igkiv55vbwqaa3x))/mileg.aspx?page=GetObject&objectname=mcl-324-75101 accessed 27 September 2014.

[650] State of Minnesota Revisor of Statutes, *2014 Minnesota Statutes - 16B.328 Outdoor Lighting Fixtures Model Ordinance*, available from https://www.revisor.leg.state.mn.us/statutes/?id=16B.328 accessed 27 September 2014.

[651] New Mexico Legislature, *House Bill 461 49th Legislature - State of New Mexico - First Session*, available from http://www.nmlegis.gov/sessions/09%20Regular/bills/house/HB0461.pdf accessed 27 September 2014.

controlling non-environmentally friendly lighting or eco-friendly lighting for specific purposes not only enhance the desirability of local or municipal policies for preserving dark-sky landscapes and the night environmental, but these certain policies also expand environmental areas for outdoor lighting control within local or municipal planning development and create certain minimum levels of lighting. In particular, where the minimum harmonised requirements of local or municipal light pollution control is motivated on the common grounds of astronomical or environmental protection rules laid down in the U.S. model laws (i.e. the *MLO*, the *LEED* and the *MMGBO*) transposing a variety of municipal measures, a number of U.S. municipalities receiving various aspects of the U.S. model law could entitle each municipal jurisdictions to apply their substantive regulatory framework.

To identify and describe the strengths and weaknesses of the allowance of U.S. Model law for municipalities' adoption in the U.S. jurisdiction, this subheading will address the ability to respond effectively to implementing appropriateness of existing instruments and other relevant incentives. Whilst U.S. model law generally requires public interest concerns to raise awareness of the written legal instruments for proper implementation, it offers the U.S. localities or municipalities who deem it appropriate an alternative route to prevent municipal light pollution.

Since the legal aspects of outdoor light use planning and zoning developed in response to unacceptable risk to human health or the night environment, there is a close intellectual and effective fit between sustainable outdoor light use targets and sound environmental risk management. There is both substantial environmental and dark-sky experience in, and a strong legal basis for, using local lighting zoning and urban lighting use powers to achieve the successfulness of limiting excessive or obtrusive emission of light pollution proven to be harmful to astronomical observation, ecological diversity and other relevant impacts as mentioned in Chapter 2. Therefore, a number of U.S. model laws strengthen a set of minimum harmonised rules where the U.S. municipal regulatory frameworks of the professional lighting bodies and that of each requested localities or municipalities provide for a similar type or level of astronomical or environmental protection.

However, there are some weaknesses will increase complexity and duplication for American light practitioners as well as their U.S. legal system. A new range of light pollution control terms law covering environmentally friendly lighting standardisation and urban lighting zoning will be enforced and administered by some U.S. municipal authorities where in U.S. municipalities a particular part of non-environmentally friendly lighting impacts is located or responded. Nevertheless, various standards and many different targets of each U.S. model law will impose the different obligations on a range of different aspects across municipal jurisdictions, making it more difficult for local authorities that control in more than one purpose of light pollution control. For example, the current key U.S. model frameworks impose different obligations on light pollution control, depending upon where many particular targets of light pollution protection are located when there are differences in implemented municipal laws. Even when U.S. model laws are similar, a range of differences in enforcement approaches can slightly lead to additional complexities between general lighting requirements for old construction and minor renovations and specific lighting requirements for new constructions and major renovations because of different obligations on the *MLO*'s general regulatory outdoor lighting requirements for meeting minimum joint IDA and IES standards and the *MMGBO*'s specific regulatory outdoor lighting requirements for meeting a minimum *LEED* Silver Certification. This means that double complexities related to light pollution control might increase if cross-disciplinary of preventive light pollution control were to be included in different pieces of the municipal laws, particularly with regard to the regulatory differences between old developments and new developments contained in these instruments.

A very good example of this is New York State jurisdiction. The increase in the expansion of poor fixtures and non-environmentally friendly design both in intrinsically dark-sky landscapes and urban brightness areas in New York State has brought with it inefficient lighting problems, particularly with main forms of inefficient lights at night. The New York State Government has recently published a number of proposals in the form of the enacted *New York Bill of 2014 (A.7489-B/S.5275-B)*[652] that restricts the

[652] Rosenthal, L. B., *Assembly member Linda B. Rosenthal's Bill to Reduce Light Pollution, Increase Use*

luminous power of lighting fixtures installed or maintained by the state. Furthermore, as discussed above, identifying legal aspects of New York's light pollution control are composite, both in determining whether the *Town of New Castle's Local Law Enacting a Green Building Law 2011*[653] that is based on the *LEED* Silver certification standards for green building's light pollution prevention is required, and when determining the content of any requirements of the *New York Bill of 2014 (A.7489-B/S.5275-B)*[654] that restricts the luminous power of lighting fixtures installed or maintained by the state.[655] This means that the Town of New Castle as a part of New York State jurisdiction requires a new development (i.e. new constructions and major renovations) assessment of both general *New York Bill of 2014 (A.7489-B/S.5275-B)* and specific municipal *Town of New Castle's Local Law Enacting a Green Building Law of 2011* on the light pollution control before development consent is granted.

In many cases, however, many U.S. municipal jurisdictions retain much of the risk to human health or the night environment, even though it does not appear on some potential measures in many U.S. municipalities. Increased complexity has arisen for a number of reasons. The first is the role of decentralisation in addressing municipal light pollution problems. The relative boundary of U.S. Central or U.S. State Governments' interventions to reduce outdoor light pollution, complexity and non-interconnectedness of the possible constraints of decentralisation in coping with all areas of municipal light pollution problems that they will generally pose even more risks to the specific municipal targets than other general light pollution awareness and therefore could be subject to a more intensive form of municipal light pollution control. As a result, the

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of Energy Efficient Lighting Passes Senate and Assembly, available from http://assembly.state.ny.us/mem/Linda-B-Rosenthal/story/58869/ accessed 27 September 2014.

[653] Schatmeier, E. H., *Avoiding Albuquerque: How Incentive-Based Green Building Codes May Regulate Appliance Efficiency Standards and Avoid Federal Pre-emption*, available from http://www.columbiaenvironmentallaw.org/articles/avoiding-albuquerque-how-incentive-based-green-building-codes-may-regulate-appliance-efficiency-standards-and-avoid-federal-preemption accessed 27 September 2014.

[654] State of New York, *Bill S5275B-2013 Restricts the luminous power of lighting fixtures installed or maintained by the state*, available from http://open.nysenate.gov/legislation/api/1.0/pdf/bill/S5275B-2013 accessed 27 September 2014.

[655] New York League of Conservation Voters, *2014 Environmental Progress Report*, New York League of Conservation Voters, 2014, pp 1-12.

efficient scale of decentralisation of transfer of functions of a U.S. Central or U.S. State Governments may be expanded, increased by advances in various forms of decentralisation, for example, political light pollution control decentralisation, administrative light pollution control decentralisation, fiscal light pollution control decentralisation, and market-based decentralisation in relation to light pollution prevention, that will allow municipalities to control general or specific aspects of municipal light pollution to perform their municipal enforcement. The second reason for increased complexity is a lack of harmonised approaches for legal awareness, in this case an unacceptable consequence: U.S. localities lack the necessary scientific knowledge to educate their local people. Raising awareness of the growing astronomical or environmental impact of municipal light pollution, especially in an educational context is considered in appropriate step processes. Several methods of linking light pollution prevention to the educational curriculum may be carried out by municipal educational system. Decisions on educational problems in relation to public light pollution awareness could be made when the implementation of U.S. model law is clearly set out, so that the outcome of awareness of light pollution can be responded to by various types of U.S. educational institution.

8.2.2.9 England

In contrast to existing or current English light pollution laws (i.e. the *Clean Neighbourhoods and Environment Act 2005* and other relevant English frameworks), this research takes the critical view of the role and effectiveness of English light pollution law that all aspects of light pollution, such as critical perspectives in light pollution effects, legal challenge for classifying light pollution types and legal light pollution definition, are likely to be analysed by this subheading, which is more concerned with English legal problems than in other foreign jurisdictions.

As mentioned in Chapters 2, 3 and 4, essential components of English light pollution control under the *Clean Neighbourhoods and Environment Act 2005* have been greatly influenced by the significant awareness of the potential consequences of the non-environmentally friendly or unnecessary lights being emitted in the wrong place at the

wrong time, and by the regulatory framework of reforms being undertaken in the most predominant contexts of the expanding areas of light pollution awareness where uncertainty of harmful illuminating engineering technologies or architectural lighting design methods remains about the probability and consequences of environmental harm. Even though this regulatory framework includes a key element of measures for the reduction of intrusive or obtrusive light; either through statutory nuisance from artificial light established or by newly updated soft law instruments as non-legally binding instruments (i.e. the *Institution of Lighting Engineers' Guidance Notes for the Reduction of Obtrusive Light* and the *British Astronomical Association's Campaign for Dark Skies' Lighting Guidance*), through a range of statutory frameworks and other relevant mechanisms, legislatures, policymakers and campaigners are being expected to demonstrate to stakeholders who are affected by, or interested in, risk how they are considering the further impacts of all key aspects of light pollution, such as visible glare, upward lights and intrusive lights within English law.

The urban expansion of district brightness areas in England increased dramatically, and some stakeholders found it very difficult to prevent the creation of adverse effects of non-environmentally friendly lighting or inefficient lighting at source and ideally such measures for controlling all main principles of light pollution should identify all means of tackling the unnecessary or inappropriate lighting effects of a single national proposal. However, the *Clean Neighbourhoods and Environment Act 2005* fails to fully acknowledge all important aspects of light pollution control. There are a number of possible reasons for the lack of specific environmental and planning mechanisms through which the step processes of non-environmentally friendly lighting assessment and inefficiency lighting management can be explained to all relevant stakeholders of outdoor lights, and acts as a statutory approach to multidisciplinary measures for tackling all key elements of light pollution in England. Two critical questions of this subheading arise. First, if the *Clean Neighbourhoods and Environment Act 2005* was inappropriate, what regulatory improvements may be needed in English environmental and planning regulations? Second, what is the appropriate level of English light pollution control?

There are seven potential reasons for the lack of specific environmental and planning mechanisms in England. First, as referred to key elements of light pollution in Chapter 3, the current artificial light nuisance under the *Clean and Neighbourhoods Act 2005* as a key English light pollution legislation has effect for the object of making such provision as is necessary in order to comply with the regulatory requirements of light intrusiveness. On the other hand, it has not concentrated on other matters of non-environmentally friendly or inappropriate lighting, other than intrusiveness of lights. People are all affected by some uncertainties in English laws relating to the definition of a degrading night environment at some point in their night lives, the local authorities are able to investigate an artificial light nuisance on people's behalf.[656] Alternatively, the need for a person who makes a claim in a lawsuit to prove a light intrusiveness claim can be effective, where the burden of proof is on the accused to prove that the defence applies to him on a balance of probabilities, or evidential, where the accused must bring sufficient evidence for the defence to be a light intrusiveness issue, and then the prosecution must disprove the defence.[657] On the other hand, the scientific and technical nature of an artificial light nuisance regulating outdoor lighting is immensely complicated.[658] If the plaintiffs do not prove the cause of intrusiveness of artificial light and demonstrate prejudice to health or an artificial light nuisance, they are not able to be taken by an individual to tackle an artificial light nuisance when the intrusiveness of artificial light interferes with an individual's use and enjoyment of his or her property. Therefore, an artificial light nuisance may represent a flexible solution in English statutory nuisance concepts[659]and address statutory law problems without the fixed-effect metric of the level of an artificial light nuisance for prejudice of human health and

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[656] South Holland District Council, *Advice on Taking Private Nuisance Action Section 82 - Environmental Protection Act 1990*, available from http://www.sholland.gov.uk/NR/rdonlyres/493F0968-6BE9-4900-B369-C229B2C66B4B/0/Adviceontakenprivatenuisanceaction.pdf accessed 27 September 2014.

[657] House of Lords, *Clean Neighbourhoods*, available from http://www.publications.parliament.uk/pa/ld200405/ldbills/031/en/05031x-d.htm accessed 27 September 2014.

[658] Turner, R. K., *Blinded by the Light: The Enforcement of Outdoor Municipal Lighting Ordinances in Texas*, available from http://www.tmcec.com/files/6214/2567/8002/00-_Turner_BINDER_Blinded_by_the_Light.pdf accessed 27 September 2014.

[659] Washington State Department of Ecology, *Air Quality Maps of Maintenance Areas*, available from http://www.ecy.wa.gov/programs/air/other/namaps/Web_Map_Intro.htm accessed 28 August 2014.

the night environment. There is no consensus as to the best means of illustrating systematic evaluation of the intrusiveness of artificial light through certain illuminating engineering metrics which are designed to assess the aggregate level of intrusive light emission through single neighbour intrusive light measurements or intrusive light direction modelling and, thereby, provide a (legally) defendable basis for statutory nuisance appraisal.[660]

Second, while unacceptable risk to human health or the night environment has previously been expressed in terms of light pollution impacts as mentioned in Chapter 2, the fragmentation of English statutory law in relation to public outdoor lighting, in cases of conflicts of human rights which are in any case considered as a part of how the significant impact of public lighting should be assessed, leads to negative consequences in conflicts of the rights to enjoy lighting in public outdoor areas and the rights to a public healthy environment. The Government has not set out in the *Clean and Neighbourhoods Act 2005* to provide the most appropriate balance between enabling full protection against the loss of dark-sky landscapes or night environment in the event that non-environmentally friendly outdoor lights shine upwardly into the public atmosphere in England. Some undesirable consequences of the sky glow that hangs over district brightness areas at night (i.e. direct upward lights and upward reflected lights) generally change the night environment where the Government and local authorities fail to fulfil their principal aims of tackling or mitigating outdoor light pollution at night. Sky glow and other relevant causes of urban atmospheric smog may affect the right of everyone to the enjoyment of the highest attainable standard of physical and mental health and prevent public light pollution from enjoying their right to healthy night environment in such a way as to affect people's individual and family life adversely. [661]

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[660] One way to resolve the ambiguities surrounding all matters of artificial light intrusiveness would be to give the clear measurable metrics complete assessment for indentifying, reducing and managing all adverse impacts of intrusiveness of artificial light. See Hooper, P., Maughan, J., Flindell, I. and Hume, K., *Indices to enhance understanding & management of community responses to aircraft noise exposure*, OMEGA Community Noise Study,2009, p 4.

[661] While the aggregate impact of atmospheric sky glow on communities depends on the entire daily emission of outdoor light and operational public facilities, each light installation has an instantaneous impact on community well being. Therefore, a class of single measurable sky glow metrics could be established to allow for quantification of each outdoor light premise. The purpose of these metrics is to

While the question of whether the English legal system has not played an important role in tackling the imbalance problem between the right to public outdoor lights and the right to healthy night environment is highly controversial, there have been some critical reviews examining this legal issue in the next Chapter (Chapter 9). Imbalance of uses of lights and light pollution control can be enforced through either the legal instrument for the control of direct upward lighting or by environmental zoning for outdoor lighting control within urban development plans and other planning applications which means English legislatures have to provide a variety of legally binding instruments available to this specific legal problem. Again, this research particularly recognised that certain metrics and parameters for dark-sky quality involving SI Unit measurements are desirable for effective light pollution control functioning and that light pollution regulations may undertake them due to involvement in a wide range of other legal reasons based on urban planning development awareness. For example, in response to the public sky glow awareness, the Government may prepare an urban development plan and a comprehensive atmospheric sky glow rule that utilise atmospheric light emission and outdoor light modelling in order to establish measurable dark-sky quality standards that are linked to urban zoning classifications.[662] In other words, the environmental zones for outdoor lighting control within their urban development plans could be coordinated with identifying how to better coordinate the urban planning process (and related urban lighting facility plans) with the local comprehensive land use planning process. The resource guide to assist local governments in identifying and implementing appropriate compatible land use tools would be the best way to slow down the proliferation of outdoor lighting sprawl in district brightness areas or allow the maximum permitted metrics of outdoor light source intensity as well as building luminance.[663]

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ensure that no light premise is more excessive or obtrusive than acceptable community standards, regardless of frequency or time of day. See Jensen, L., *Planning for Airport Noise: The Roar of Discontent*, Massachusetts Institute of Technology, 2013, p 7.

[662] City of Los Angeles Department of City Planning, *Noise Element of the Los Angeles City General Plan*, City of Los Angeles Department of City Planning, 1999, p 2-1.

[663] Federal Interagency Committee on Aviation Noise, *Land Use Compatibility and Airports*, available from http://www.fican.org/pdf/Land_Use_Planning_and_Airports.pdf accessed 28 August 2014.

Third, some forms of modern light innovations are related to outdoor lighting activities requiring permits non-environmentally friendly forms of lights from their inappropriate or unnecessary light uses, e.g. surrounding emissions of light emitting diodes (LED) and other relevant qualities of blue-rich light sources. It, therefore, seemed to be accepted that these modern aspects of illuminating engineering technology and architectural lighting design might be poorly addressed in areas of specific legal issues associated with the use of outdoor blue-rich lighting technology in England. For example, expansive growth of urban LED street light fixtures and design has a number of negative impacts on human health and the night environment; in other words, local authorities in English jurisdictions still retain much of the unacceptable risk to which exterior lights from sources of modern LED street light technologies are installed increasingly even though they emit surrounding light pollution themselves through normal uses of outdoor blue-rich lights for safety and visibility reasons. The metrics of blue-rich spectrum (short-wavelength) light are an attempt to emulate the manner in which humans respond to non-environmentally friendly wavelength.[664] The maximum acceptable level for night lighting may be considered safe from an environmentally friendly lighting perspective.[665] A key challenge in managing the LED blue-rich spectrum wavelength from an economic perspective is to balance the costs of outdoor light energy efficiency with the costs of controlling human health and the night environment.[666] The next Chapter will guide the way for non-environmentally friendly light wavelength control, the creation of regulatory metrics that evaluate the level of exposure to the harmful portion of the non-environmentally friendly light spectrum while permitting the rest of the energy efficient use of LED light at an acceptable level.

Forth, the English regulatory lighting requirements (i.e. the *Clean and Neighbourhoods Act 2005* and the *Road Vehicles Lighting Regulations 1989*) generally focuses on

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[664] Essilor of America, *Blue Light Hazard: New Knowledge, New Approaches to Maintaining Ocular Health*, Essilor of America, Report of A Roundtable, New York, 16 March 2013, p 1-12.

[665] Department of Mechanical and Nuclear Engineering, *Noise Metrics and Regulations*, available from http://www.mne.psu.edu/lamancusa/me458/4_metrics.pdf accessed 28 August 2014.

[666] Department for Environment Food and Rural Affairs, *Environmental Noise: Valuing impacts on: sleep disturbance, annoyance, hypertension, productivity and quiet*, Department for Environment Food & Rural Affairs, 2014, p 11.

human well-being and safety effects that English people may experience within a visual range of the night hours and a visual equivalent of the day hours after sources of outdoor light emitted excessive or intrusive lights.[667] For reasons of light pollution control in England, the paper argues that current requirements have not established certain degrees of light pollution and asset classifications of legal minimum standards for the light pollution prevention in English jurisdiction. For example, the primary role in establishing governance standards for setting certain degrees of light pollution control is generally played by the professional lighting bodies through their non-legally binding requirements of high standards of conduct for light pollution control e.g. the *Institution of Lighting Engineers (ILE)'s Guidance Notes for the Reduction of Obtrusive Light 2005* and the *British Astronomical Association's Campaign for Dark Skies' Lighting Guidance*. The advent of non-legally binding standards for environmentally friendly lighting necessitates that lighting stakeholders from all relevant bodies address the degrees of light pollution in a more measurable way than what have been the unclear or uncertain degrees of light pollution in the past, for example, certain measurable degrees

[667] Only few English legal frameworks establish base lighting rules on protecting from excessive brightness from glare and consequent risks. The setting of illumination standards sets out principles for protection from the effects of headlight glare and the effects of glare from workplaces, such as the *Road Vehicles Lighting Regulations 1989* and the *Management of Health and Safety at Work Regulations 1992*. Although the English previous and current legal frameworks do not cover all aspects of light pollution, reference to such categories of glare will be made only where necessary in order to control some situation of glares. The *Road Vehicles Lighting Regulations 1989* (RVLR) introduce many lighting requirements for headlamps control in order to improve road safety. To simplify the criteria that determine whether the front and rear position lights on vehicles, legal requirements to comply with legal aspects governing the fitting and usage of headlamps generally force drivers to use good headlights in the time between half an hour after sunset and half an hour before sunrise. These provisions provide a requirement for a lamp fitted to a vehicle to have specified horizontal and vertical angles of visibility is a requirement that at least 50 percent of the apparent surface must be visible from any point within those angles when every door, tailgate, boot lid, engine cover, cab or other movable part of the vehicle is in the closed position. They will be minimise glare in a way which would dazzle or cause discomfort to other road users, including pedestrians and cyclists. They ban use front or rear fog lights unless visibility is seriously reduced to avoid dazzling other road users. Additionally, the *Workplace (Health, Safety and Welfare) Regulations 1992* (MHSW) require employers, or those who have control over health and safety in the workplace, to take into account employees with special lighting needs. For example, light flicker may trigger seizures in some people with epilepsy. Employers will need to prevent this risk by providing appropriate lighting or adequate lighting control measures and managing the health and safety risks from light pollution in the workplace. See UK Legislation, *The Road Vehicles Lighting Regulations 1989*, available from http://www.legislation.gov.uk/uksi/1989/1796/made accessed 24 June 2013 and see also Health & Safety Executive, *Lighting at Work HSG 38*, Her Majesty's Stationery Office, 2002, p 32.

of outdoor lighting fixtures and design. Light practitioners are able to calculate the certain degrees of all major light pollutants regulated by the soft law: outdoor light Intensity in Cd (Candela), outdoor luminance in Cd/m2, and outdoor luminaire flux. For each of these degrees, they have established national certain dark-sky measurable standards to protect human health and the night environment. In addition, under provisions of the *Clean and Neighbourhoods Act 2005*, the artificial light nuisance is a key feature of the legislation, with the Act 2005 setting artificial light nuisance requirements for English people and all local authorities. However, it does not provide all degrees of outdoor light pollution to local authorities and professional lighting bodies on certain written requirements that are likely to be followed if a number of recent official statements on human health and the night environment are raised in order to threaten harm to human health or the environment under the precautionary principle as mention in Chapter 5. Consequently, the local authorities may request the enforcement of certain minimum degrees of outdoor light practices than is provided for under the current regulatory frameworks of the requested authority.

Fifth, the amount of inefficient commercial, industrial and housing lights shining needlessly into the sky, notably in urban areas, mainly reduce the efficiency of astronomical observatory telescopes and interfere with general ability to study the sky because lower magnification from artificial sky glow that hangs over district brightness areas has mainly mitigated the benefit of darkening the background sky when professional and amateur astronomers are observing through light pollution. There are some dark sky parks[668] in the UK, for example, the Galloway Forest Dark Sky Park[669], the Exmoor's Dark Skies as well as the Sark Dark Sky Island where the forestry

[668] The International Dark Sky Association (IDA) defines a dark sky park as: "*a park possessing exceptional starry night skies and natural nocturnal habitat where light pollution is mitigated and natural darkness is valuable as an important educational, cultural, scenic and natural resource. May be part of a larger Dark Sky Reserve, or may not.*" See International Dark-Sky Association, *International Dark Sky Reserve Program (Version 1.2)*, International Dark-Sky Association, 2008, p 14.

[669] Owens, S., *Galloway Forest Dark Sky Park – Stargazers Welcome*, Science and Technology Facilities Council, 2010, p 3. and See La Société Sercquaise, *Sark Hailed as the World's First Day Sky Island*, available online from http://www.socsercq.sark.gg/News%20and%20Projects/darkskiespressrelease.html accessed 10 September 2013. and See Owens, S., Exmoor − Europe's first International Dark Sky Reserve, available online from http://britastro.org/journal/pdf/121-6exmoor.pdf accessed 10 September 2013.

governing bodies have established dark sky parks as the light pollution control landscapes in the UK. Nevertheless there are no specific legal instruments which govern relationships between the conservation of astronomical dark landscapes and light pollution restrictions. Again, the current artificial light nuisance under the *Clean and Neighbourhoods Act 2005* has effect for the purpose of making such provision as is necessary in order to comply with the lighting intrusive control requirements, but the legal regime in the English jurisdiction does not make specific provision to require environmental and planning governing bodies when making strategic decisions about the exercise of their functions to have regard to the desirability of reducing astronomical light pollution.

The English environmental and planning governing bodies are generally subject to the usual structure of local government, each one has its own National Park Authority (NPA) with public responsibility for natural conservation management and fostering the outdoor astronomical activities of local communities.[670] On the other hand, as a consequence of the lack of environmental and planning provisions for astronomical light pollution control in England, environmental and planning governing bodies and local authorities might merely act or obey within the intrusive light pollution control law. Therefore, direct upward lights or upward reflected lights are major causes of astronomical light pollution and waste of energy, will not be helped to minimise by the English public sector and legal frameworks.

This research particularly urges the UK Government and other public sectors to ensure that in future, specific legal provision for astronomical light pollution control is constructed on the basis of legal aspects for controlling the brightening of the night sky above the English night sky landscapes as well as urban district areas. Firstly, to map the astronomical observatory areas and to take adequate or coordinated measures to reduce astronomical light pollution, the urban environmental areas or landscapes for outdoor lighting control within the planning strategies or frameworks should be set up by the Government and environmental and planning governing bodies. Secondly, the

[670] Tunnicliffe, S., *A Landscape Legacy: National Parks and the Historic Environment*, English Heritage & The Countryside Agency Landscape Access Recreation, 2006, pp 1-21.

planning policy frameworks are generally carried out in coordination with the environmental and planning legislation and the astronomical lighting requirements, for example, guidance for illuminating engineering installations, guidance for the limitations of the effect of upward lights from architectural design, and other legal requirements dealing with astronomical light pollution. Finally, astronomy education should give people, astronomers, public sectors and local authorities the astronomical light pollution knowledge to function effectively and responsibly when observing the night sky or practicing their night sky environment precaution as well as preservation. So, the enforcement actions of the astronomical or environmental areas for outdoor lighting control within national planning frameworks have not been successful across three parts of the UK (i.e. England, Wales, and Northern Ireland), in particular best practice astronomical or environmental zoning, the development of enacting for protecting urban or rural dark-sky landscapes. The boundary of an environmental area for outdoor lighting control may be at least minimum degrees of outdoor lighting at night from the outdoor lights of any district brightness areas or dark-sky landscapes to be protected within planning control, although these areas will constitute major reforms of urban or rural outdoor lighting practices in the UK. While it is difficult to argue against all aspects of urban planning development as mention above, one could argue that for reasons of inconsistency with several existing provisions of the English planning laws, as the local authorities have no legally binding approaches for zoning their environmental district brightness areas or dark-sky conservation landscapes in order to create a level playing with a national planning regime, the urban zoning of the light pollution control might also apply when planning enforcement is used.

Sixth, the *Clean Neighbourhoods and Environment Act 2005* currently extends necessary elements of the statutory nuisance to cover artificial light emitted from premises and interferes with someone's property or intrudes upon areas not intended to be lit. Nonetheless, the Act 2005 excludes some sources[671] of light pollution from

[671] Artificial light nuisance can cause annoyance, stress and sleep disturbance and in some cases escalate into serious confrontations within neighbourhoods. Some of this light comes from public facilities, such as airports, goods vehicle depots, lighthouses, railway and bus stations, defence premises and prisons. Warning labelling of these public facilities' light pollution would assist people living near public

outdoor lighting for safety and security reasons, such as airports, goods vehicle depots, lighthouses, railway and bus stations, defence premises and prisons.[672] Outdoor lights from transportation, safety, and security premises provide outdoor illumination to enhance the safety and security of outdoor premise users for which every local authority in England has been carrying out a review of outdoor light premises in their area, but this does not mean that all outdoor illumination is environmentally friendly or appropriate illumination which does not involve all major elements of excessive or obtrusive lights in England.[673] For example, the expansion of upward light near to and above the horizontal from airport lights at night is able to emit extreme orange smog (sky glow) of sodium vapour illumination that comes from various aviation brightness facilities (i.e. airport car park lights, runway approach ramp lights, visual approach slope lights, and taxiway lights).[674] The next Chapter particularly seeks to answer two key questions. First, why was the danger from the emerging imbalance between the exterior lighting from transportation, safety, and security premises and the night environment protection in the English legal system that led to the legal issues not identified more clearly through making regulatory decisions about exterior light pollution? Second, when the non-environmentally friendly illumination from transportation, safety, and security premises began to impact, were necessary or proportionate environmental and planning measures adopted? Both aspects have been addressed with a specifically focus on the balance of the lighting and the healthy environment across English jurisdictions.

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premises to control light pollution themselves. As well as providing people with light pollution information to make informed choices, the test procedures incorporated into any warning labelling regarding light pollution will provide more certainty that public facility operator's claims about light levels of outdoor public premises are reliable. See NSW Department of Environment, Climate Change and Water for the Working Group on Noise Labelling, *Australian and New Zealand Noise Labelling and Limit Scheme – Recommendations For Portable Equipment*, NSW Department of Environment, Climate Change and Water for the Working Group on Noise Labelling, 2010, p 11.

[672] Morgan - Taylor, M., 'Light Pollution and Nuisance: The Enforcement Guidance for Light as a Statutory Nuisance', 2006 August, *Journal of Planning & Environmental Law*, available from http://www.britastro.org/dark-skies/pdfs/JPEL2006_08.pdf accessed 03 October 2013.

[673] Morgan-Taylor, M., 'Light Pollution and Nuisance: The Enforcement Guidance for Light as a Statutory Nuisance', *Journal of Planning & Environment Law*, 2006 August, pp 1114-1127.

[674] Morgan-Taylor, M. & Mizon, B., 'Light pollution now subject to the criminal law of statutory nuisance', *Journal of the British Astronomical Association*, 2005 115 (3), pp 119-126.

Seventh, despite the previous Government's acceptance of light pollution problems many years ago, there is no specific legal framework governing ecological light pollution control. Although artificial light nuisance could be defined as any form of artificial light which interferes with someone's use of their plants, and / or is or may be prejudicial to pet and / or farm animal's health under the *Clean Neighbourhoods & Environment Act 2005* as a statutory nuisance, the current law governing light intrusion does not substantially apply for all aspects of the conservation of natural habitats and of wild fauna and flora.

Furthermore, there is no specific law to confer responsibility on all public bodies to tackle all aspects of ecological light pollution, and in England, the current statutory laws do not usefully provide the principles of ecological light pollution control. For example, the *Wildlife and Countryside Act 1981* does not specifically set up certain methods of ecological light pollution control, although some species are fully protected under the *Wildlife and Countryside Act 1981*.[675] Similarly, the *Natural Environment and Rural Communities Act 2006* importantly makes provision about public bodies concerned with the natural environment and rural ecosystems and all public bodies must consider the impact artificial light will have on biodiversity in their jurisdictions.[676] On the other hand, this Act does not widely strengthen legal protection for threatened species by making environmental and planning measures with respect to ecological light pollution control. Likewise, in English jurisdiction, some populations of rare natural habitats, wild fauna and flora have been protected and considered to be of ecological interest, following standard given in the current legal frameworks; nevertheless they have not created specific measures that have a wide range of lighting practices and governance.[677]

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[675] Bruce-White, C. & Shardlow, M., *A Review of the Impact of Artificial Light on Invertebrates*, Invertebrate Conservation Trust, 2011, p 11.

[676] Ibid, p 22.

[677] To ensure the Government continues to protect night environment while growing the urban development and expansion the planning sectors need effective national environment law. The *Town and Country Planning Act 1990* is the main piece of national planning framework for consolidating certain enactments relating to town and country planning. However, this framework does not cover environmental matters of sky glow and does not provide a vital and valuable role in supporting the basic

In Conservation and National Parks landscapes, the night environment and the heritage of dark skies are not only essential to dark-sky preservation, but also conserve nocturnal environment and ecological species that have special adaptations that particularly help them live in the night environment. English people share the areas and landscapes with a wide variety of nocturnal species; however the current environmental and planning laws in England, the *National Parks and Access to the Countryside Act 1929*, the *Planning (Listed Buildings and Conservation Areas) Act 1990* as well as the *Environment Act 1995*, do not consolidate certain enactments relating to ecological light pollution control in respect of environmental zones for exterior lighting control within the environmental and planning laws, for example, the restrictions regarding lighting practices that are essential to intrinsically dark landscapes and low district brightness areas.

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sky glow prevention. Whilst urban expansion or urban sprawl has continued to affect the night environment, planning measures are needed to ensure that the brightening of the night sky from upward lighting over urban areas do not reduce the value of the dark night sky and the night environment. In a similar way, the UK was the first country to publish a national *Biodiversity Action Plan (BAP) in 1994* that was a particular response to the *Convention on Biological Diversity (CBD)*, which the UK signed up to in 1992 in Rio de Janeiro. Furthermore, the UK recently set out common purpose and shared priorities to address biodiversity challenges though the UK Post-2010 Biodiversity Framework which promote national legislation and relevant international obligations relating to biodiversity and ecosystem. However, there is no a guiding framework for specific environmental and planning actions on sky glow protection. The UK legal regime does not formally underpin specific regulatory actions which focus on the resilience of biodiversity and ecological system to sky glow in night environment as explained in Chapter 4. Considering these ecological concerns together, the British Government should keep up to date with all progresses of sky glow problems through specific legal requirement. The aspects of sky glow may be set out by the proposals for new laws, and plans to change existing laws, that are presented for debate before legislators. While the conservation legislation for England sets out many legal measures to conserve and protect wildlife and habitats and areas of outstanding natural beauty (AONB) or areas of special scientific interest (SSSI), English legal frameworks do not provide high standards of ecosystem or ecological area protection concerning the appropriate sky glow prevention through environmental light fixtures and environmental zoning for exterior lighting control. For example, The Law Commission has recently reviewed legal aspects of species protection legislation in England and Wales since the creation of the *Wildlife and Countryside Act 1981*. Although Law Commission's review must result in English and Wales's jurisdiction which the conservation laws should support positive conservation actions, enabling England and Wales to meet its global, European and domestic obligations to conserve biodiversity and reverse species' declines from environmental pollution and its harms, nevertheless the Law Commission's reviews do not especially introduce a response to increasing concern about the declines in ecological populations resulting from sky glow. See Joint Nature Conservation Committee, *UK Conservation*, available from http://jncc.defra.gov.uk/page-5281 accessed 9 July 2013. and see further Joint Nature Conservation Committee, *UK Post-2010 Biodiversity Framework*, Joint Nature Conservation Committee, 2012, pp 1-14.

Light uses is needed for some parts of Conservation Areas and National Parks, for example, lighting for special architectural or historic beautification interest and lighting for National Parks' accommodation, but light in the wrong place at the wrong time can be intrusive. This research, therefore, considers there to be benefit to environmental and planning governing bodies for the assessment of ecological light pollution and proposes to proceed with their requirements of environmentally friendly lighting, following the development of suitable lighting practices to do so.

These are seven major reasons why some legal problems were abandoned related to light pollution concerns in English jurisdiction while many elements of outdoor light pollution remain quite uncertain on the measurable scale of excessive or obtrusive lighting control under the context of *Clean and Neighbourhoods Act 2005*. Nevertheless, apart from the above elements, the key protection in any rights to healthy environment against the harmful effects associated with non-environmentally or unnecessary lighting practices should be the national regulatory functions – the main focus of this comparative law research in this Chapter.

8.2.3 Clarifying the comparative light pollution control laws (comparative study of law for light pollution control purposes)

Encouragement to legal studies of light pollution can take a number of legal research styles. One way to review the role of regulatory mechanisms in English legal system is by focusing on how comparative law came to be regarded as several necessary and proportionate aspects to fill gaps in existing English environmental and planning laws. This subheading extends the use of comparative techniques in environmental and planning law to comparative law research. Although the use of comparative law for the international and European light pollution control is discussed in chapter 6 & 7 above, the international and European legal systems have not yet generated several specific elements of light pollution control and they have limitations of their regulatory mechanisms when the international and European instruments have not played an increasingly important role in precautionary or preventive approaches for light pollution control since scientific researches permitted a complete evaluation of the risk to human

health, nocturnal species or the dark-sky environment; consequently, these existing regulatory instruments of international and European environmental and planning law are less obviously suited to all aspects of light pollution control that were detailed in the face of several possible dangers of non-environmentally friendly or unnecessary outdoor lights at night in national, regional or local jurisdictions. Furthermore, in some cases, central, regional or local governments themselves have exceeded the environmental and planning regulatory frameworks for light pollution control, particularly in the area of specific light pollution problems, where some specific astronomical or environmental problems have to be prevented or mitigated by justifying decentralisation of decision-making for addressing specific astronomical or environmental problems. As discussed above, there are research opportunities for us to investigate necessary or proportionate legal measures of England by examining and comparing similarities and differences of the existing international, national, regional and local regulatory regimes.[678] We will especially consider legal circumstances of the decision making on the necessary or proportionate to the merits of comparative law where there is a need for reforming English law to codify and simplify statutory light pollution measures[679] by applying some of the rules of light pollution law contained in the different international, European, national and local principles[680], it is beneficial to choose the key elements of light pollution control that should guide the English policy makers and legislatures in their choices of the applicable measure of light pollution control. In contrast to making decision on the necessary or proportionate to the merits of comparative law mentioned above, which apply to reform of the English light pollution law, this research particularly highlights the limitations of using comparative study to reform English light pollution law[681], for example, legal, political, and geographical, educational, cultural

[678] University of California, Davis School of Law and University of Insubria School of Law in Como, *International Comparative Environmental Law Seminar (Critical Topics in Environmnetal Law in A Comparison Perspective)*, International Comparative Environmental Law Seminar, Como, 25 May - 6 June 2014, p 3.

[679] Kimber, C. J. M., 'A Comparison of Environmental Federalism in the United States and the European Union', *Maryland Law Review*, 1995 4 (54), pp 1658-1690.

[680] Germani, A. R., *Environmental Law and Economics in U.S. and E.U.:A Common Ground ?*, University of London School of Oriental and African Studies, 2004, pp 1-20.

[681] Murchison, K. M., 'Environmental Law in Australia and the United States: A Comparative Overview', *Boston College Environmental Affairs Law Review*, 1995 3 (22), pp 503-561.

and demographical differences between legal systems and environmental needs that apply in various meaningful ways to lighting for environmentally friendly purposes.

8.2.3.1 Suggested good practice from a critical analysis of example light pollution law

The role of comparative law generally presents the common differences and shared similarities of environmental and planning law. Regarding the environmental and planning law and other relevant disciplinary context, the consequences of environmental and planning law doctrines will be systematically analysed, and a strategic view of environmental pollution will be used to provide the organising scheme of the legal materials in this field.[682] Despite the widespread importance of the debate on the variability of specific environmental protection purposes and planning development functions, there are very few robust evaluations that allow meaningful comparisons of the stringency of light pollution law in different international, European, and national jurisdictions to be made.[683]

If we pursue a comparison between various jurisdictions[684], we are able to meet a number of challenging legal problems in different international, regional and national jurisdictions as mentioned above. In other words, many differences of light pollution law from various forms of regulatory lighting practices under which different origins and contexts of light pollution law generally are subject to more stringent environmentally friendly or efficient lighting standards than those applied to existing sources. [685] Therefore, many parallels and discussion of the consequences of different light pollution law for our understanding of the role of comparative light pollution law

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[682] Gomez, F., *Course: Comparative Law and Economics of Contracts*, New York University, 2012, pp 1-9.

[683] Gouldson, A., Carpenter, A., and Afionis, S., 'An international comparison of the outcomes of environmental regulation', 2004 (9) *Environmental Research Letters*, available from http://open.nysenate.gov/legislation/api/1.0/pdf/bill/S5275B-2013 accessed 28 September 2014.

[684] Bermann, G. A., Patrick, G., Kim, L. S., Amr, S., David, V. S. and Elisabeth, Z., 'Comparative Law: Problems and Prospects', *American University International Law Review* 2011 4 (26), pp 935-968.

[685] Te-Chung Tang, D., 'The Environmental Laws and Policies of Taiwan: A Comparative Law Perspective', 1993 (521) *Vanderbilt Journal of Transnational Law*, available from https://digital.lib.washington.edu/dspace-law/bitstream/handle/1773.1/966/3PacRimLPolyJs089.pdf?sequence=1 accessed 28 September 2014.

are explored. In doing so, we particularly concentrated on the role that comparative law play and the joint or shared light pollution contexts moulded by common forms of light pollution law. In particular, we stressed how choices of necessary or proportionate measures have led to outcomes of law reform that would lead the solution of a problem which arises because English light pollution law and its relevant legal methods are outdated and obsolete.[686] New ways of obtaining transplantation or reception of foreign legal ideas become more preferable as the English legal system modernises and takes greater advantage of legal advances in measuring outdoor light pollution, for example by offering local light pollution risk control in certain stage process whereby localities undertake their preliminary assessment of their urban brightness areas and dark-sky conservation landscapes, to specify urban development areas where potential non-environmentally friendly lighting risk still exists. In other ways, we may alternatively propose introducing a new criterion of illuminating engineering and architectural lighting design which are likely to be suitable for alternative measures of light pollution prevention in the English legal system. The role of comparative law may improve its English light pollution control standing by enacting new legal reforms that shape the English legal system more effectively than other legal systems with respect to new alternative actions, yet do not improve the modern regulatory establishment into a more practical form of English light pollution control.

Furthermore, while there are some differences for light measures, the fundamental U.S. light pollution control standards from existing U.S. non-legally binding frameworks as soft laws were consistent with many national jurisdictions, and that the U.S. regime has progressed through similar standards to the EU regime, such that the latest *LEED*'s green building standards are similar to the green building standards of the recent *Energy Efficiency Directive (European Commission Directive 2012/27/EU on energy efficiency).*[687] In other words, lighting standards of soft laws, in harmonising their impacts across states and on imports to the international, national, regional and local

[686] Whelan, D., *The Comparative Method and Law Reform*, LLM Thesis, University College Dublin, 1988, p 232.

[687] European Commission Directorate-General for Enterprise, *STUDY N°1A Comparison of EU Air Quality Pollution Policies and Legislation with Other Countries*, available from http://www.pedz.uni-mannheim.de/daten/edz-h/gdb/04/study1.pdf accessed 28 September 2014.

jurisdictions, are assumed to have negated any major potential impacts on environmental protection to affected lighting practice reform.[688] The role of comparative law therefore plays in the process of harmonisation of transnational and regional light pollution law.[689] A comparison on light pollution control standards relating to environmental and planning law may take place when a number of joint or shared risks to human health and the dark-sky environment have occurred, causing similar light pollution impacts. Based on the various elements of light pollution law from various jurisdictions as mentioned above, comparative law is able to incorporate current development issues and legal problems faced by jurisdictions exposed to non-environmentally friendly lighting harms and inefficiency lighting.

Observing new legal ideas and regulatory techniques[690] enhanced light pollution control may be offered to measure when and what kinds of illuminating engineering technology and architectural lighting design is integrated into precautionary and preventive approaches for non-environmentally friendly lighting control at all levels. Light pollution control law in England, including that related to artificial light nuisance, has been greatly influenced by the English common law and court precedent in the English legal system has explicitly sought to keep artificial light nuisance in harmony with English law. However, the role of comparative law is able to help England build an alternative choice of international light pollution responses and establish modern light pollution control stage processes[691] by adopting necessary or proportionate elements of international or European environmental and planning law before reforming the English light pollution law as mentioned in Chapter 6. In its response to the reform of English light pollution legislation, England may better[692] deal with effective protection of the

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[688] Dall 'O', G., Bruni, E. and Panza, A., Improvement of the Sustainability of Existing School Buildings, *Energies*, 2013 (6), pp 6487-6507.

[689] Banakas, S., *The contribution of Comparative Law to the Harmonisation of European Private Law*, Comparazione e diritto civile, 2014, pp 1-12.

[690] Kahn-Freund, O., 'On Uses and Misuses of Comparative Law', *Modern Law Review* 1974 1 (37), pp 1-27.

[691] Zweigert, K. and Kotz, H., *Introduction to Comparative Law Volume I: The Framework*, Clarendon Press, 1987, p 2.

[692] The National Archives, *A better quality of life - strategy for sustainable development for the United Kingdom - 1999*, available from http://collections.europarchive.org/tna/20080530153425/http://www.sustainable-

dark-sky environment than other jurisdictions in the future.

The current literatures on environmental and planning law in the legal context of light pollution have been reviewed and analysed in order to identify comparative approaches concerning the light pollution control standards, resulting in an English framework for this aspect in the context of English light pollution. However, the previous literature in England has not been successfully reviewed to highlight the critical elements of comparative light pollution law which demonstrate necessary or appropriate functions of comparative law and practical methodology of comparing light pollution laws from many jurisdictions. The focus of this research is specifically concerned with the legal system and elements of the existing international, European and light pollution laws to develop detailed and intensive knowledge about the future law reform by applying necessary or appropriate techniques of comparative law.

To know and understand the law of foreign countries[693], the critical elements of comparative light pollution law have to be designed to analyse the effectiveness of light pollution control. If the functional comparative law is used for the meaning of a better-law comparison in the context of methodological principle of the comparative law functionality[694], the functionalism of comparative law can lead to comparability of all aspects of different foreign and English regulatory mechanisms and other relevant contexts of light pollution. [695] Even though the magnificent role of comparison on foreign and English light pollution law proposes a number of alternative choices of connecting academic points with parallel undertakings in legal critique – such as environmental management and urban planning development or socio-legal studies – have been referred to, there is another dimension worth extrapolating. These functional comparative techniques provide sources of critical discussion that help

development.gov.uk/publications/uk-strategy99/10.htm accessed 28 September 2014.

[693] Pieters, D., *Functions of comparative law and practical methodology of comparing or how the goal determines the road!*, available from https://www.law.kuleuven.be/personal/mstorme/Functions%20of%20comparative%20law%20and%20practical%20methodology%20of%20comparing.pdf accessed 29 September 2014.

[694] Winterton, G., 'Comparative Law Teaching', *American Journal of Comparative Law*, 1975 1 (23), pp 69-118.

[695] Acuna, R. M., *Comparative Law From Below: The Construction of a Critical Project in Comparative Legal Studies*, Lambert Academic Publishing, 2012, p 3.

legislators, policymakers and other relevant stakeholders to compare and choose between different appropriate measures for the outdoor lighting standards and can help the Government to make decisions that lead to better outcomes of legal reforms in the future.

8.2.3.2 The use of comparative law analysis in light pollution control law

The principles of comparative law generally appear to analyse the similarities and differences of a principle-based approach to regulatory light pollution control in different countries for three reasons. Each comparison is in part purposes because in terms of the comparative law method of legislators or policy markers, the formal concept of the comparative light pollution law means that the comparative law methodology should be capable of guiding legislators or policy markers' legal reasoning and the regulatory conduct of lighting stakeholders.[696] First of all, many regulatory light pollution frameworks from common law countries and civil law countries rely upon historical backgrounds of regulatory responses to international and national light pollution problems[697], particularly in the similarities and differences of relationships between the organised environmental movement backgrounds and the light pollution law development in legal systems. Second, concepts of the functional comparative approach to light pollution and their potential applicability on each specific comparison[698], which involves comparing key elements of light pollution legislation on the legal basis of their illuminating engineering and architectural lighting design solutions to relatively similar problems[699], has the important advantage of international

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[696] Ambrus, M., 'Comparative Law Method in the Jurisprudence of the European Court of Human Rights in the Light of the Rule of Law', *Erasmus Law Review*, 2009 2 (3), pp 353-371.

[697] Siems, M. M., *Legal Origins: Reconciling Law & Finance and Comparative Law*, University Of Cambridge Centre for Business Research, 2006, p 6.

[698] Comparative law must not only accept the concept that common and civil legal systems form traditional lighting, cultural lighting, or other relevant lighting aspects, but also must find some means to account for the common or joint philosophy of lighting standards. See Hicks, S. C. 'The Jurisprudence of Comparative Legal Systems', *Loyola of Los Angeles International and Comparative Law Review*, 1983 4 (6), pp 171-199.

[699] Taylor von Mehren, A., 'Choice-of-Law Theories and the Comparative-Law Problem', *American Journal of Comparative Law*, 1975 23 (4), pp 751-758.

and regulatory reform[700] because many countries across the world need to have regulatory authorities in place to shape their environmentally friendly lighting standards by modelling common elements of light pollution laws to serve as a shared legal template for those charged with making decisions concerning growth of astronomical and environmental light pollution problems at all levels. Third, many potential harms of modern illuminating engineering technology and architectural lighting design may be considered by the comparative light pollution law when astronomical scientists or professional lighting bodies have recently assessed the likely significant adverse impacts of modern lighting at night.[701] The alternative way to find out whether the comparative light pollution law will be used is to ask them to consider whether they may need to take a precautionary approach to both the scientific lighting development and law reform.[702] This looks at the potential for significant regulatory stage processes that are of international, European and national importance, also critically analysed below is how to find out whether a number of legal light pollution standards are required. The comparative light pollution law will become more emphasised and some lighting technologies and activities will become newly subject to modern elements of light pollution law in the future.

As mentioned above, many nations have their coincidental jurisdictions for light pollution law with their environmental agencies, local authorities, public organisation and professional lighting bodies regarding astronomical or environmental matters. While legislative controls on outdoor light pollutant emissions from illuminating engineering fixtures and lighting architectural design in different jurisdictions are

[700] Ackerman, B., 'Reforming Environmental Law: The Democratic Case for Market Incentives',1988 (141) *Yale Law School Faculty Scholarship Series*, available from http://digitalcommons.law.yale.edu/cgi/viewcontent.cgi?article=1140&context=fss_papers accessed 29 September 2014.

[701] Comparative legal research can give us an improved knowledge as to whether specific illuminating engineering and architectural lighting elements of light pollution law reforms and structures are causally conditioned by modern forms of lights (i.e. blue-rich white outdoor lighting practices). See Verhulst, S. G. and Price, M. E., 'Comparative Media Law Research and its Impact on Policy', 2008 (1) *International Journal of Communication*, available from http://ijoc.org/index.php/ijoc/article/viewFile/323/164 accessed 1 October 2014.

[702] Cameron, J. and Abouchar, J., 'The Precautionary Principle: A Fundamental Principle of Law and Policy for the Protection of the Global Environment', *Boston College International and Comparative Law Review*, 1991 1 (14), pp 1-27.

regulated in any different way to other legislative pollution emission control, a comprehensive legal analysis of regulatory light pollution requirements gives a critical view of the different laws and regulations governing the control of light pollution and the provision of outdoor lighting practices. Therefore, we compare various similar and different elements of the light pollution frameworks which provide each unique legal specialisation in one of the most rapidly developing areas of global and national pollution. We comparatively illustrate the similarities and differences of backgrounds and legal contexts, such as law origins, regulatory bodies with responsibilities for the dark-sky environment, light source standards, lighting practice standards, urban development zoning for outdoor lighting control and other relevant exemptions of light pollution requirements.

Comparative light pollution law has within its academic foundations the elements of comparative regulatory lighting requirements for dealing with potential light pollution at night. Firstly, the comparative origins of light pollution laws among astronomical studies, environmental sciences, illuminating engineering, architectural lighting, and other relevant legal studies are complex. The view advanced here, while the spread of urban outdoor lighting facilities generally contributes to a longstanding phenomenon of urban district brightness landscapes, has deeper roots of existing regulatory measures reaching back to the philosophical foundation of dark-sky conservation, environmentally friendly lighting and energy efficiency. The outdoor light pollution control is one of the environmental and planning law studies some jurisdictions of the main legal systems have been keen to address as part of their environmental and planning law reforms. Many recently significant parts of the existing regulatory frameworks have fallen inside mainstream astronomical dark-sky protection because the influence of professional astronomical bodies on legislative authorities in the main legal systems of the world is exerted on the ways in which people, local authorities and public astronomical organisations are obliged to conduct their outdoor lighting practices in modern society, for example, the U.S legal system and Canadian legal system identify and create national soft laws (i.e. the *IDA and IES Model Lighting Ordinance* and *RASC Light Pollution Abatement Programme*) that are effective, and, in therefore

doing, provide astronomical and environmental solutions where outdoor light pollution issues reside without interfering with other legislative opportunities at national level. Likewise, the Japanese legal system and Chilean legal system lead their interaction between the legislative agencies and public astronomical organisations that take the regulatory forms of addressing to minimise their selected astronomical impacts of light pollution on the dark-sky conservation environment, for example, the *Optical Environmental Disruption (Light Pollution) Prevention Ordinance in Bisei 1989* of Japan and the *Emission Standard for the Regulation of Light Pollution – Supreme Decree N°686/98 Ministry of Economy* of Chile attempt to minimise astronomical light pollution by taking appropriate action when the requirements of the following dark-sky Bisei, Antofagasta, Atacama and Coquimbo municipal landscapes for outdoor lighting control within their national regulatory frameworks are not being met. This means key legal systems of the world view, either general problems or specific problems as regulatory forms of public light pollution awareness that are most valuable as astronomical or environmental purpose input into other national and local exterior illuminating activities. Again, this means that once philosophical foundation of light pollution law - for example, the dark-sky heritage conservation and the sustainable lighting development - can shape very similar and substitutable regulatory approaches to outdoor light pollution control. On the other hand, these research critics argue that a vision of what new illuminating engineering or architectural lighting laws' purposive elements should be in the coming next decades because of lighting technology development.[703] As a result of modern lighting practices, the philosophical foundation of light pollution law may involve modern lighting changes carried out in favour new origins of light pollution concepts and responsibilities. The critical questions of how to treat modern lighting technologies, be they blue-rich white outdoor floodlights, Pro-Teq star path glow, or other relevant modern lighting technology, can no longer be answered by the existing philosophy of light pollution law that existing regulatory provisions from main legal systems of the world do not support.

Secondly, a number of regulatory bodies with responsibilities for the dark-sky

[703] Chaisson, M., 'Book Notes: The Philosophical Foundations of Environmental Law: Property, Rights and Nature, by Sean Coyle and Karen Morrow'. *Osgoode Hall Law Journal*, 2005 3 (43), p 350.

environment are able to lead legal enforcement of dark-sky protection legislation to carry out any instrument or mechanism that measures outdoor light pollution emissions relative to a basis of light pollution law in both national and local levels. However, in this research study, we comparatively analyse the different forms of regulatory bodies set by jurisdictions where there were different astronomical and environmental demands from outdoor lighting stakeholders, appearing in centralised command form, decentralised administrative form or other astronomical governing form. Decentralisation of light pollution control is the transfer of responsibility for controlling local light pollution and managing dark-sky conservation areas from the central government and its public astronomical or environmental authorities to field units of government authorities, subordinate units, regional government, local government, or astronomical public service organisations.[704] In principle, local government and public astronomical organisation will be the beneficiaries of decentralisation as local light pollution control and astronomical public service powers are passed to them through the national light pollution frameworks and the central government will have a regulatory role in passing light pollution control power to localities, municipalities, and astronomical public services. By decentralising light pollution control over the localities, municipalities, and astronomical public services, the central government not only empowers the regulatory functions, but also set regulatory power to pass municipal ordinances, local bylaws, or astronomical dark-sky regulations. This means the levels of light pollution legislation may be specific or general depending on whether the regulatory bodies with responsibilities for the dark-sky environment have powers to pass their light pollution legislation and the differences between light pollution laws are thought to be the sources of law, its decentralised subjects, and decentralised level matter. For example, the English Government and French Government were passed, including their national light pollution laws (i.e. the *Clean Neighbourhoods and Environment Act 2005* of England and the *law n°2009-967 of 03 August 2009 relating to the implementation of the Grenelle Environment project of French*), which established the primary role of the

[704] Food and Agricultural Organisation of the United Nations, *Chapter 2 Decentralization and environmental issues*, available from http://www.fao.org/docrep/005/y4256e/y4256e05.htm accessed 1 October 2014.

environmentally friendly lighting standard in recognising the good practices of outdoor lighting and the functions of regulatory bodies at national level. In other words, decentralisation of light pollution control in Japan and Canada involves the transfer of power from the Japanese Government and Canadian Government to local authorities, which do a lot of the work to meet the national environmental and energy requirements and are authorised to pass necessary or desirable light pollution by-laws for municipal light pollution control purposes (i.e. Japanese and Canadian Municipal Towns passed the *Optical Environmental Disruption (Light Pollution) Prevention Ordinance in Bisei 1989 of Japan* and the *Town of Richmond Hill's Light Pollution By-law of Canada* for purposes considered necessary or desirable including the outdoor efficient lighting practices and dark-sky protection purposes).

Thirdly, light pollution emitters and outdoor lights may share common sources of lighting, but non-environmentally friendly sources of lights left on can contribute the misdirection of light and the excessive level of light in district brightness areas, whereas the most important factor for dark-sky quality is the concentration of poor light pollutants nearer the urban or suburban locations. As mentioned in Chapter 2, it has become increasingly clear that unnecessary or inappropriate sources of exterior light at night play a role in determining risks to people and the night environment. It should be noted, however, that different world regional and national jurisdictions employ their own different proposed approaches to carrying on regulatory requirements for the standards of environmentally friendly and energy efficient light sources in outdoor areas. We critically analysed when, in different regions of the world, the increases in influence of the legal systems due to outdoor light pollution will become large by comparison with the influence of legal regimes in relation to light source standards that are always present. In the European legal system, the existing EU law in eco-design of energy-related products (*Energy-related Products Directive 2009/125/EC (ErP)*) imposes different obligations on modern light source standards depending upon Member States' adoption and implementation where Member States and other relevant light stakeholders (i.e. manufacturers, producers, service providers, suppliers, wholesalers, distributors and retailers) will have the same regulatory roles and legal

obligations wherever they are in EU legal regime as mentioned in Chapter 7. This means the EU regulatory frameworks and Member States' regulations aim at reducing the environmental impact of light-related products, including the energy consumption throughout their entire life cycle by the labelling to raise the awareness of consumers and the energy efficiency requirements as an economic incentive or market-based instrument of the European Union regime. Some EU Member States, such as England, French, Italy, Spain and Slovenia, adopt both general legislation designed to reducing the environmental impact and inefficiency energy impact of light-related products and they also adopt specific legislation designed to limit light pollution throughout their outdoor light source requirements. For example, the use of classic incandescent light bulbs has been banned and phased out in EU Countries including England. Some legal systems in Europe meet the test of both European energy-related product standards and light sources standards regarding the enforcement of sustainable energy efficient measures. In U.S. jurisdiction, similar subject about energy efficiency light products arise about how U.S. law sets energy efficient requirements for outdoor light sources, as these circumstances of inefficient light sources need to be minimised by the law. The requirements of creating energy efficient lamps or blubs, as set out in the *Energy Independence and Security Act 2007*, set out what the light stakeholders have to do in response to the inefficiency energy impact of light-related products in U.S. jurisdiction. The U.S. law requires about 25 percent greater efficiency (that is, less energy use) for household light bulbs that have traditionally used between 40 and 100 watts of electricity. However, it does not ban the use or purchase of incandescent bulbs and it does not ban the sale or manufacture of all forms of incandescent bulbs. Using two key examples from European and U.S. jurisdictions above, even though the ban on inefficient incandescent lamps or bulbs has not been enforced by several jurisdictions where their applicable provisions of regulatory light pollution frameworks are already well established, all light stakeholders from various jurisdictions of the world have not yet been required by their legal systems to produce light products for specific outdoor illuminating purposes that minimise main causes of obtrusive light and waste of energy less energy than light products for specific indoor illuminating purposes. In the other words, we argue that the users of light products for specific indoor illuminating

purposes may accept the risk of light pollution impact on health and the built environment when they use their indoor lights in all indoor areas. On the other hand, the users of light products for specific outdoor illuminating purposes may adversely present serious public astronomical and ecological light pollution problems in urban brightness areas or intrinsic dark-sky landscapes. That is why it is important for both central governments and local authorities to learn how to control light pollution in public outdoor areas through light source standardisation. Despite the unique standards exhibited by the existing market-based instruments regarding eco-labelling mechanisms under global lighting market, there is no public interest in ensuring that light pollution product knowledge, under both international and national market-based mechanisms, are appropriately provided (i.e. light pollution warning labels attached to the outdoor light product are an alternative method of applying the polluter pays principle of environmental law). We critically analyse the legal issues in more detail below and notably wherever we discuss how light consumers feel knowledgeable when using lamps and light bulbs that may lead to major causes of outdoor light pollution.

Fourthly, the non-environmentally friendly or inappropriate practices of outdoor lighting at night within the aspects of light pollution are the negative uses of lights requiring those technical, poor lighting forms referred by means of outdoor light pollution, or their relevant adverse impacts, as defined in Chapter 2. In general, the light pollution laws require the proposer to include several legally binding practices of outdoor lighting (i.e. full cut-off outdoor light shielding, switching off outdoor lights during the curfew hours and ban on outdoor use of upward light beam displays) which have been considered, if no optional written requirements have been considered none need be included in their legal systems as mentioned above. The certain written requirements which involve different approaches to meeting sustainable light pollution control needs (i.e. the requirements to control obtrusive light and upward spread of light through either local authorities' practices or people's practices) can legally be expected in the light pollution law from both common and civil legal systems. However, the requirements of the light pollution control are very similar despite the differences of comparative legal contexts, for example, levels of law-making in relation to levels of

government, traditional legal systems, and non-legally or legally binding force. For example, under the municipal *Town of New Castle's Local Law Enacting a Green Building Law of 2011* on the light pollution control of the U.S. New York jurisdiction, the Town of New Castle's planning authorities can suspend or revoke a green construction or sustainable building certification issued under legal principles of the U.S. *LEED* green building law for any conviction of regulatory light pollution requirements substantially related to both the *LEED* green building qualification and Town of Newcastle' green building certification. Similarly, under the municipal *Town of Richmond Hill's Light Pollution By-law* of the Canadian jurisdiction, the Town of Richmond Hill's planning authorities for granting construction site plan approval can refuse to grant construction site plan approval for such development if the required lighting plan for outdoor light pollution control has not been filed and approved by the planning authorities. Success to comply would render any similar requirements to control obtrusive light and upward spread of light through either local authorities' practices or people's practices open to challenge in both U.S, and Canadian jurisdictions, which means the discretionary planning decision could be adopted if it complied with the light pollution requirements at municipal level. Therefore, regulatory requirements for national and local lighting practices are based on all legal approaches to controlling environmental risk management and providing minimum requirement that is consistent with good lighting practice under the environmental and planning law. On the other hand, this comparative law research is continuing to engage with the new aspects of harmful light pollution and we strongly believe this is important for the public to understand more about the comparative environmental law and the critical arguments that seek to address new aspects of light pollution control through sustainable lighting practices. For example, in the cases of harmful LEDs hazardous, especially concerning claims about some adverse impacts to human health or to the dark-sky environment, many international, national and local jurisdictions have not yet promoted going straight to the public as preferable to the more disciplined approach of suitable LEDs lighting practices.[705] We comparatively analysed this lack of light

[705] Seong-Rim, L., Kang, D., Ogunseitan, O.A. & Schoenung, J.M., 'Potential Environmental Impacts of Light-Emitting Diodes (LEDs): Metallic Resources, Toxicity and Hazardous Waste Classification',

pollution measures as a new area of harmful illuminating technology in all jurisdictions, and argued that there will, in fulfilling the future specific regulatory functions of hazardous blue-rich outdoor lighting practices[706], help to contribute to new regulatory light wavelengths requirements and provide further reform to the light pollution regulations in fulfilling environmental, energy and planning objectives at both national and local levels.

Fifthly, the principles of urban development zoning for outdoor lighting control become both non-legally binding guide (soft law) and legally binding guide (hard law) to urban planning development, especially in accordance with an expansive urban outdoor lighting and intrinsic dark-sky conservation plan, for example, the *MLO* (American soft law), the *ANPCN Plan for Sky and Night Environment Protection* (French soft law) and the Spain's Andalusia autonomous regional *Decree 357/2010* (Spanish hard law), as mentioned in Chapter 5, even though this is not compulsory in many national and local jurisdictions. The urban development zoning for outdoor lighting control happens when local governments and their planning authorities need to cope with the sprawl of outdoor light installations because comprehensive zoning is a significant mechanism for protecting human health, human safety and the dark-sky environmental by separating incompatible outdoor illuminating uses from one another.[707] The parameters of urban development zoning for outdoor lighting control as a regulatory mechanism to ensure the levels of upward light ratio of the installation, vertical luminance, light intensity and luminance is measurable standardisation of outdoor light pollution level, that confirm demonstrated results of non-environmentally friendly outdoor light areas, or that address environmentally friendly outdoor lighting landscapes, are more likely to be assessed by local governments and local planning authorities. These planning aspects will need to be underpinned by effective urban planning development, including suitable parameters and other relevant measures to ensure that outdoor light pollution

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Environmental Science & Technology 2011 45 (1), pp 320-327.

[706] International Dark-Sky Association, *Visibility, Environmental, and Astronomical Issues Associated with Blue-Rich White Outdoor Lighting*, International Dark-Sky Association, 2010, pp 1-23.

[707] Nolon, J. R., *Zoning and Land Use Planning*, available from http://landuselaw.wustl.edu/SSRN-id1345426[1].pdf accessed 1 October 2014.

problems are fully realised by national and local planning regimes. Alternatively, the protection of outdoor light pollution at night through establishing specific zones for outdoor lighting control is another planning instrument choice. It is specifically balanced with the intrinsic astronomical dark-sky landscapes and nocturnal conservation areas imperatives of the present. The philosophical aim of specifying particular areas for outdoor lighting control is to establish a balanced approach to development that not only recognises the contribution of the astronomical dark-sky environment, but is both naturally and nocturnally deliverable. So, the solution of specifying particular areas for outdoor lighting control has been innovative: the creation of written national or local frameworks to ensure that the public interests of both astronomical observatory studies and wildlife nocturnal park are balanced in specific astronomical observatory areas. For example, specifying particular areas for outdoor lighting control would enlighten in the cases of Chilean and Japanese jurisdictions, where national government and local authorities would have identified the outdoor light pollution problems being run by their local authorities and people through their previous uses of non-environmentally friendly or inappropriate outdoor lights at night. So, once again, the *Emission Standard for the Regulation of Light Pollution – Supreme Decree N°686/98 Ministry of Economy* of Chile and the *Optical Environmental Disruption (Light Pollution) Prevention Ordinance in Bisei 1989* of Japan presented by the specific area problems to achieve a more judicious regulatory lighting control in both jurisdictions has been successfully fulfilled. Compared with both zoning approaches, measures such as urban development zoning for outdoor lighting control and specifying particular areas for outdoor lighting control are at an advantage in meeting the conditions for outdoor light pollution control; however, they make a difference to the final outcome. The urban development zoning for outdoor lighting control sets clear specifications of the roles and responsibilities of the local authorities and people to ensure appropriate clarity of the environmental areas for outdoor lighting control (i.e. intrinsically dark landscapes and district brightness areas) within their urban planning regimes, and at the same time protects general public interests. On the other hand, specifying particular areas for outdoor lighting control is identified as a method for controlling light pollution in the specific local or regional dark-sky sites (i.e. intrinsically dark-sky sites). This research emphasises the importance

of establishing effective areas for outdoor lighting control through both urban development zoning for outdoor lighting control and specifying particular areas for outdoor lighting control. The law reform will be appropriate to clarify how organising areas for outdoor lighting control will be applied in analysis by this research as part of how the local governments and their local planning authorities prevent light pollution problems by following our modern aspects of urban planning development, for example, preliminary light pollution impact assessment and compulsory dark-sky mapping. Further details on how new aspects of planning law on light pollution control will be reformed set out in this research are outlined below.

Finally, for a clear understanding of the context of light pollution law within which the comparative law in this research is presented, we also comparatively examine the critical arguments on the exemptions of light pollution laws; and through a comparative analysis, show the extent to which a number of exemptions in national or local jurisdictions cannot ensure that the light pollution provisions are achieving their regulatory aims – the overall one being to reduce emitting light pollution from non-environmentally outdoor light fixtures and design as parts of a wider light pollution control agenda – and are accordingly interested to argue exceptions to outdoor light pollution control policy. While public service bodies may need an exemption to prevent their outdoor safety and security activities from causing light pollution or harming human health the dark-sky environment, comparative law enables us to analyse the respective ideas of the different exempted premises and the balance between light pollution emission allowances and the right to a safe and healthy dark-sky environment. The artificial light pollution generally means by which elements of outdoor light pollution are regulated in both national and local jurisdictions are different between various purposes for regulatory light pollution control; however, the adverse impacts of artificial light from exempted premises are consistent. The exemptions in light pollution law are generally included for public interest reasons that support significant effort to maximise safety and security, particularly where the public interest in respecting risks to safety and security is required, for example for transportation safety purposes or for military security defences, or in any other case where exempted premises are necessary

to support whether the likely positive impacts on the safety and security of that particular outdoor lighting development will be significant in that particular location of the base stations for public interest lighting facilities. As discussed in Chapter 2, the amount of different outdoor light pollutants from several exempted premises that are emitted to the urban brightness areas and intrinsic dark-sky conservation landscapes from outdoor activities in legal systems not only cause a number of negative environmental effects, but also have consequent impacts on different performance characteristics of exempted premises themselves, for example, military aircraft operations that are associated with several different types of spatial disorientation[708] and ecological seabirds that are attracted to and collide with lighthouses.[709] Some are examples of the *Clean Neighbourhoods and Environment Act 2005* of England and the *Arizona State's House Bill Title 49 (Chapter 7)* of U.S. Arizona State and the *Decree 357/2010, August 3rd, which approves the regulations for the protection of the night sky quality against light pollution and the establishment of measurements for energy saving and efficiency of* Spain's Andalusia Region which established the similar exemptions, in which airport lighting facilities and infrastructures are covered. A critical question then obviously arises on what necessary or proportionate enforceability of exemption provisions in light pollution legislation the public service bodies should provide such that the balance between light pollution emission allowances and the right to a safe and healthy dark-sky environment when exemption of regulatory frameworks allowed public service lighting facilities to emit outdoor light pollution. Legal problems may arise if exemptions allow public service facilities to emit light pollution which has linked excessive or obtrusive light at night to a variety of problems including astronomical observation, ecological system and performance characteristics of public service facilities.

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[708] Johnson, C.W., *Interactions between Brown-out Accidents and Night Vision Equipment in Military Aviation Accidents*, available from http://www.dcs.gla.ac.uk/~johnson/papers/JWSSC2009/Brownout.pdf accessed 2 October 2014.

[709] Thompson, D., *Effects of ships lights on fish, squid and seabirds - Prepared for Trans-Tasman Resources Ltd*, National Institute of Water & Atmospheric Research Ltd, 2013, p 9. And see further Crawford, R.L. 'Bird kills at a lighted man-made structure: often on nights close to a full moon', 1981 (35) *American Birds*, available from https://sora.unm.edu/sites/default/files/journals/nab/v035n06/p00913-p00914.pdf accessed 2 October 2014.

This subheading concluded that the comparison of similarities and differences is clearly easy for all jurisdictions to apply necessary or proportionate criteria of outdoor light pollution control to their national or local jurisdictions where they have experienced outdoor light pollution in their non-environmentally friendly or inappropriate exterior lighting practices. It has examined the influence of soft law within the professional astronomical bodies as well as illuminating engineering bodies on standard-setting in light pollution frameworks. Central or local governments from several jurisdictions, for example, U.S., France and Canada, have already accepted all the key harmonised aspects of the soft law and intend to implement these in their national and local jurisdictions, with the aim of reducing all key elements of light pollution and combating non-environmentally friendly or inefficient outdoor lighting practices. Some jurisdictions are, however, sometimes not only regulatory but are also intend to develop their own regulatory measures to prevent some particular forms of light pollution, for example, the Slovenian legal system significantly sets out a clear set of aspects governing outdoor illuminating façades of the cultural monuments and historical buildings. Some jurisdictions also intended to develop their own legal actions against the light pollution due to the some key forms of their non-environmentally friendly or inappropriate lighting practices, for example, artificial light that is allowed to illuminate or intrude upon areas not intended to be lit (i.e. intrusive light) is considered to be a statutory nuisance in English and French legal systems. The use of both statutory instruments and written regulatory mechanisms in soft law and hard law has presented a legal challenge to the traditional sources and the joint functions of light pollution law in global legal system.

8.2.3.4 Identifying contemporary legal concerns in setting out legislative changes which are part of a basic reform of light pollution legislation

The comparative study of the similarities and differences between several light pollution laws from common law and civil law jurisdictions not only presents a legal challenge to the traditional sources and the joint functions of light pollution law in a global legal system, but also identifies areas of legal problems where lack of clarity of how existing national or local light pollution law can lead to tackle all aspects of light pollution in

some national or local jurisdictions. Several jurisdictions have already reviewed some of the fundamental principles and recently focused on the responsibilities of the astronomical and environmental stakeholders in furthering the regulatory requirements of their national and local law in the light pollution areas as mentioned above. On the other hand, these jurisdictions have not yet given the specific environmental concerns to apply regulatory mechanisms or legal instruments necessary to the particular environmental, economic and social circumstances. Therefore, this subheading gives a better understanding of particular weaknesses and specific legal problems of light pollution law in order to analyse a strong better solution for the future law reform in both English and foreign jurisdictions.

Comparative law plays a significant role in finding prospective solutions to questions of gaining understanding of common or shared light pollution problems.[710] We recognise that the sky glow, glare, and intrusive light are magnificent sources of light pollution whose stability can be affected by uncontrolled outdoor light installations of industrialisation and urbanisation. Many jurisdictions, like our example countries as mentioned above, have their contemporary light pollution problems caused by the large excessive or obtrusive light pollutants connected to unnecessary or inappropriate outdoor lighting practices. The basic concept of the international environmental and planning law referred to in Chapter 6 and 7 is that each member state must afford to nationals of other member countries the same environmental protection and urban planning development it affords to its own nationals, but the international environmental and planning law have not yet set out how states or nations can apply existing international legally binding commitments such as international environmental agencies to bring together national governments, national environmental agencies, local authorities, people and other relevant light stakeholders (i.e. manufacturers, producers, service providers, suppliers, wholesalers, distributors and retailers) to make further steps towards integration of international commitments. It can therefore be concluded that

[710] Fairgrieve, D., *Using comparative law before the courts*, available from http://www.law.yale.edu/documents/pdf/conference/compadmin14_fairgrieve.pdf accessed 2 October 2014.

previous and existing provisions of the international environmental law have not yet received a major promotion with international obligations of states or nations, which would bring much broader attention to the light pollution problems.

Comparing light pollution legislation in European countries and other countries with the increasingly important worldwide, it was found that the different national and local jurisdictions produce similar legal measures and the techniques of comparing light pollution law are deeply rooted in astronomical and environmental principles. These proposed comparative law techniques are promising and may be beneficial to design to improve effectiveness and to target newly recognised contemporary light pollution problems such as international environmental agreements that establish international dark-sky quality standards for certain common light pollutants based on the latest science. Opening up new opportunities for international environmental bodies is able to permit central governments from several legal systems to enter into such international light pollution arrangements under specific conditions which are spelled out in sets of common or joint light pollution problems as mentioned below. Taking light pollution control as a point of global and national environmental concerns leads to specific lines of comparative analysis in relation to the English or foreign challenges that are raging through contemporary light pollution prevention.

Some similar contexts of national legal systems that better lighting practices reduces light pollution impacts is that contemporary lighting practices, like each common measure, explicitly sustain the balance between acceptable dark-sky qualities of human wellbeing, healthy environment and astronomy observation in each jurisdiction. On the other hand, we argue the case of comparative law that the different contents of every jurisdiction, (i.e. history, politics, geography, economic, demographics and culture) located in the world are not able to use their disadvantageous contexts to make better use of English or foreign law to raise effectiveness of legislative light pollution control. For example, the Scandinavian and Nordic Nations may allow necessary or proportionate options for controlling geographical outdoor lighting at night where the more extreme impacts of longer and shorter daylight hours in Scandinavian and Nordic countries at different times of the year may be geographically explained by the

geographical influence of latitude and longitude. If the Scandinavian and Nordic jurisdictions need to set out changes which are part of a reform of light pollution legislation, they may consider their changes in the intensity of sunlight that reaches the land's surface carefully in preparing the outdoor artificial light standards and the exterior lighting practice requirements. Consequently, the Scandinavian and Nordic legal systems would necessitate suitable outdoor light curfew hours on floodlight when the Scandinavian and Nordic sunlight brightness remains visible at the midnight.

The international and European law generally gives us the chance to ensure national or local jurisdictions have regulatory regimes which work for both environmental protection and planning development as mentioned in Chapters 6 and 7. On the other hand, there are a range of international and European requirements they would not have the specific ability to deal with the expected increase in international or transboundary light pollution harms across all jurisdictions covered by the international or European legally binding frameworks and at the same time fulfil all of the international or European environmental and planning requirements (e.g. sustainable planning development). Although there are non-legally binding proposals in place that deal specifically with international or transboundary light pollution or other aspects of appearance as mentioned in Chapter 6, they do not set out compulsory aspects that national governments and legislative bodies will need to consider when developing and implementing their public light pollution policy.

When considering how the light pollution law should be sourced, the nations or states may give highest priority to the consideration of the benefits of simplifying existing provisions of the international environmental and planning law for legislatures or policy makers. The existing legal aspects of the international and European law may be easily available for legislatures or policy makers to adopt necessary or proportionate principles and they might seek to select particular international environmental and planning aspects that can be applied to environmental and planning law effectively.

To sum up, we concluded that it is not difficult for legislatures or policy makers to create a light pollution control regime where they have experienced non-

environmentally friendly or inappropriate lighting practices in their dealing with harmful light pollution impacts. Meanwhile, they have to consider contemporary legal concerns in setting out legislative changes which are part of a basic reform of light pollution legislation. We said that these were a range of areas of particular concerns given that contexts of light pollution law should be targeted by legislatures or policy makers as further discussed in Chapter 9.

8.3 Benefits and limitations of comparative study of light pollution control law

When considering how comparative light pollution law should be used, we have to be able to demonstrate that comparative light pollution law is being applied more potentially to provide a number of completely shared legal principles or to provide a range of common light pollution control standards with the selection of providing the latest lists of references of specific standards for environmentally friendly or appropriate lighting practices in cases of light pollution control; it is an agent of change and of harmonisation between different jurisdictions and their legal contexts as mention above.[711] Comparative light pollution law is also a term effectively used to refer to a range of major similarities and differences between the unique English legal system and the various legal systems that share both common regulatory approaches to environmental and planning regulations with other jurisdictions and some aspects of the environmental and planning law.

To achieve reasons for building on the success of the current English environmental law enforcement regimes and enhancing future planning developments in the English legal system, comparative light pollution law will compare and contrast light pollution laws in Slovenia, Japan, Italy, Spain, Chile, France, Canada and the U.S., with a view to informing future development of adapting common light pollution requirements to address the light pollution control standards and enhancing wider English reforms to light pollution control law in order to enable environmental and planning regulations to better lighting practices in England. The comparative light pollution law not only considers the joint aspects of the established practice of creating future international and

[711] Henderson, D. F., 'Comparative law in perspective', *Pacific Rim Law & Policy Journal*, 1992 1 (1), pp 1-10.

European minimum light pollution control standards through maximum regulatory harmonisation which harmonise selected aspects of light pollution law, but also comprehend future bilateral and multilateral agreements on transboundary astronomical or environmental light pollution problems when conflicting lighting interests can best be solved by cooperating environmental outdoor lighting management and sharing light pollution knowledge.

This research focuses on analysing better outcomes for control of non-environmentally friendly or inappropriate outdoor lighting practices must be pursued in a way which identifies not only the limitations of comparative light pollution law, but also the potentially negative impacts of comparative law on analytical light pollution control studies. Of course, comparative light pollution law will still be necessary for comparing light pollution control regulations based on similar and different grounds of light pollution laws to adequately support and advise England on how English legal system can propose to remove the restrictions under the *Clean Neighbourhoods and Environment Act 2005* to enable environmental governing bodies, local authorities, and other relevant stakeholders to modernise the existing English light pollution mechanisms by removing the unnecessary or inappropriate regulatory lighting requirements. However, the negative impacts of the comparative law methodology must be analytically considered: the limitations in combining the comparative light pollution law and English law reform.[712] The difficulties appear to be greatest often when it comes to comparing the light pollution of different jurisdictions. A significant note on the difficulty of comparing various jurisdictions with differing opposition of legal systems, culture, language, background, and religious difference sets out some of the challenges of making such comparisons in specific areas of light pollution control. For example, if fluency in the English language of the target comparative law research based on translation of non-English documents for comparative light pollution law purposes is a prerequisite for comparative studies, comparative lawyers have to be limited in a range of foreign legal contexts they can study by the English language they know. Consequently, the translation of foreign light pollution laws may not be critical to

[712] Whelan, D, *The Comparative Method and Law Reform*, LLM Dissertation, National University of Ireland, 1988, p 26.

maintaining documentary research trust in comparative light pollution law studies if the problem of finding translations of foreign primary or secondary legal research sources is addressed. When comparative lawyers provide sources of documentary research themselves, whether they are in the contexts of each official certified document that is open to public view or a translation involving foreign law details in English language, we expect comparative lawyers to use authentic or reliable foreign law information in ways that are consistent with the surrounding contexts of comparative light pollution law.

Chapter 9: Can comparative law explore necessary approaches for English light pollution law reform?: future opportunities and challenges

This last Chapter looks at the future trend in English light pollution law away from problematical approaches towards effective approaches. Despite choosing the necessary or reasonable regulatory measures to reform light pollution control in the selected example countries as analysed in Chapter 8, England is not clear which of the various common standards is effective for tackling all key elements of outdoor light pollution, such as sky glow, glare and intrusiveness. Our conclusion is that English law would be improved if many of the regulations could be brought together in a single light pollution law that so far as possible subjected all aspects of light pollution to a similar light pollution definition, basic abatement standards, necessary restrictions and reasonable exceptions. Legal techniques for dealing with scientific certainty and uncertainty in illuminating engineering[713] should be informed by general principles of environmental law reflecting the need for the excessive or obtrusive light control to fulfil the right to a healthy dark-sky environment.

Additionally, to give a sense of the relative numbers affected from inappropriate sources of outdoor light and non-environmentally friendly atmospheric brightness[714], this research reaffirmed the uses of measurable metrics of the International System of Units (SI) for outdoor light pollution emittance measurement as the best way of light pollution measurement and endorsed the relationship to determine community non-environmentally friendly light impacts, with broad acceptance of maximum level for outdoor lighting as a reasonable criterion, and found that the corresponding figures for public facility lights are not a source of annoyance to those who live in urban brightness areas and for those subject to lower levels of disturbance caused by non-environmentally friendly light installations and design, respectively. [715]

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[713] England is subject to a large number of potentially suspicious elements of non-environmentally friendly light emission. These typically might be a result of new aspects of illuminating engineering technology and architectural lighting design. Preparedness for all considerable uncertainty regarding the harmful light pollution will play an important role in pushing advocacy efforts forward. See Vinuales, J. E., 'Legal Techniques for Dealing with Scientific Uncertainty in Environmental Law', *Vanderbilt Journal of Transnational Law*, 2010 2 (43), pp 437-503.

[714]Butcher, L., *Aviation: noise pollution*, available from http://researchbriefings.files.parliament.uk/documents/SN00261/SN00261.pdf accessed 30 March 2015.

[715] Sizov, N. and Pickard, L., *An Update on Research to Guide United States Policy on Aircraft Noise Impact*, Policy: 11th International Congress on Noise as a Public Health Problem (ICBEN) 2011, London,

This might also improve light industry stakeholders' knowledge or, more accurately, bring the light pollution understanding closer to the global knowledge of light pollution harms.[716] This might well go some way to ensuring that all relevant light industry stakeholders have a better understanding of the law through establishing a single light pollution law.[717]

It also outlines the critical debate over the lacunae in existing English light pollution law and the need for setting new regulatory measures to control outdoor light pollution, explores a comparative law approach as a tool for reforming English light pollution law, suggests the opportunities and challenges for light pollution law reform in England, and investigates the possibility for reforming the English light pollution control legislation in the future. Many impacts on the night environment are due to light pollution where this research believes comparative law studies[718] are reasonable to improve knowledge, encourage cooperation, and perhaps establish regulations and decision-making in sustainable lighting practices.

9.1 Lacunae in existing English light pollution law and the need for setting new regulatory measures to control outdoor light pollution

After being comparatively analysed by Chapter 8 that the serious problems were inadequate safeguards against all key elements of outdoor light pollution in England, usually connected with the lack of reliable criteria, this research noted that English

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24-28 July 2011.

[716] However, when some illuminating engineering technology does not allow clear assessments of the full range of adverse effects on light pollution, such an approach would develop simplifying sources of environmentally friendly light, helping to show the appropriate course of environmental lighting in the face of uncertainty. See Sunstein, C. R., 'Beyond the Precautionary Principle', *University of Pennsylvania Law Review*, 2003 151, pp 1003 - 1058.

[717] For example, the terminology of light pollution under the statute law will be able to help all light industry stakeholders apply the conceptual knowledge of sustainable outdoor lighting practices to their own sectors. However, it is important to understand that appropriate outdoor lighting practices cannot be achieved by a single sector in isolation. The written term of regulatory light pollution control is a pervasive philosophy to which every participant in the English legal system should subscribe, if they need to meet a certain commitment to outdoor light pollution control. See Scheuer, S., *EU Environmental Policy Handbook: A Critical Analysis of EU Environmental Legislation*, European Environmental Bureau, 2006, p 15.

[718] Adler, J. H., 'When is Two a Crowd? The Impact of Federal Action on State Environmental Regulation', *Harvard Environmental Law Review*, 2006 1 (31), pp 67-114.

legislation needs to be similar to the rest of the global standards for outdoor lighting practices. This means that English law should reduce the amount of excessive or obtrusive brightness used for outdoor lighting activities to minimum environmentally friendly levels, which permits all relevant stakeholders to provide environmental and dark-sky protection.

Another main problem is that the available legal techniques for each of the main sectors regulated to control artificial light nuisance cannot be vulnerable in some areas of light pollution problem, particularly if facing a difficult public environment interest impact, such as the imbalance of the natural 24-hour day-night cycle.[719] Although English law is able to help to prevent any outdoor light to be directed at oncoming public interests in such brilliance as to impair the vision of public facility users and to be directed upon any part of a residence or into any area zoned for individual premises[720], not all areas of urban planning development concerns do, so that extending the right to a healthy night environment could encourage public environmental interest protection by all relevant light industry stakeholders and apply global standards for regulatory light pollution control. This research gave key reasons where the Government and all light industry stakeholders cannot define a wide variety of ways to redress with each, establishing global standards for outdoor light pollution control. It agrees with the necessary principles of soft and hard laws that they are able to be crucial to ensure that urban planning development in England should be controlled to mitigate light pollution impacts and encourage their analytical focus on the significant measurable metrics of

[719] One important factor that determines the survival of a species is its ability to maintain a stable balance with all other species in the dark-sky environment. See Forestry Commission Scotland, *Galloway Forest District Dark Sky Park: Application to the International Dark Sky Association*, available from http://www.forestry.gov.uk/pdf/GallowayDarkySkyApp.pdf/$file/GallowayDarkySkyApp.pdf accessed 30 March 2015.

[720] At present, lighting practices are covered by two sets of law. One is concerned with human safety and the other with artificial light nuisance. The two systems are similar: although they both address the slightly different conduct, they use existing law philosophy and legal concepts of statutory light nuisance and lead to varied outcomes. However, non-environmentally friendly threats made by a combination of reflected and refracted light from the atmospheric smog are deemed to have been made by public outdoor lights. See Lockwood, R., *A review of local authority road lighting initiatives aimed at reducing costs, carbon emissions and light pollution*, Temple Group Ltd, 2011, pp 14-15.

the balanced approach.[721]

As mentioned in Chapter 8, there are seven key reasons why some lacunae in existing English light pollution law were abandoned related to non-environmentally or inappropriate lighting concerns while many aspects of light pollution legislation remain quite uncertain on the measurable scale[722] of excessive or obtrusive lighting control under the context of *Clean Neighbourhoods and Environment Act 2005*. Firstly, the existing artificial light nuisance under the *Act 2005* as a key legislative instrument has effect for the object of making such provision as necessary in order to comply with the regulatory requirements of light intrusiveness or obtrusiveness; nonetheless, it has not concentrated on other matters of public environmental interests, rather than the statutory artificial light nuisance.[723] It remains merely a remote possibility for most light industry stakeholders due to the necessary stage processes of taking legal action and, perhaps more importantly, the risk[724] of being held non-environmental for the public dark-sky interests. It cannot balance between individual lighting value and public environmental interest.[725] It is not clear how inadequacy of the rules contributes to a lack of

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[721] Civil Aviation Authority, *Managing Aviation Noise*, Civil Aviation Authority, 2014, p 6.

[722] These concerns will be able to motivate numerous assessments of economic losses caused by light pollution to the light industry stakeholders. To estimate economic losses to them caused by key elements of light pollution, a measure of actual or predicted yield loss reflecting outdoor light consumption conditions and constraints is needed. An approximation to this desired measure may be derived from a dose-response function based on experimental field data collected across varying levels of light pollutant exposure. Economic assessments can be conducted utilising producer behaviour on costs and output as an indirect means to arrive at yield adjustments caused by light pollution. See Adams, R. M., Ledeboer, M. V. and McCarl, B. A., *The Economic Effects of Air Pollution on Agriculture: An Interpretive Review of the Literature*, Oregon State University Agricultural Experiment Station, 1984, p 11.

[723] Campaign to Protect Rural England, *Night blight!*, Campaign to Protect Rural England, 2003, p 27.

[724] Light pollution exclusions in general insurance liability, and property insurance policies generally create coverage void for many economic insureds. To fill this gap in insurance coverage in the future, a number of specialised environmental insurance policies may be developed to address a number of loss exposures in relation to outdoor light pollution impacts. In practice many of the separate coverage's are combined either by the underwriter or intermediaries to build a more complete environmental insurance program to address the needs of a particular insured as well as needs of light pollution insurance. See Dybdahl, D. J., *A User's Guide to Environmental Insurance*, available from http://www.erraonline.org/usersguide.pdf accessed 30 March 2015.

[725] The role of the public interest and its treatment by jurisdictions is an important consideration for the national Government. Atmospheric sky glow, urban brightness growth, and their associated impacts will continue to increase in their frequency and severity, despite the attempts of the most recent amendment to the Environmental Protection Act 1990 to appropriately balance the competing environmental interests

comprehension of sympathy with elements of inefficient outdoor lights shining needlessly into the public atmospheric areas such as sky glow as well as atmospheric smog.[726] While some foreign laws require the need to prevent key elements of public environmental interests by providing official frameworks of public atmospheric protection[727], English law has not yet followed the substance of the public light pollution awareness by stating that the significant harmful element of public sky glow are inefficient or non-environmental if they contain inappropriate level of light or non-environmentally friendly direction of light, or if they are likely to impact on the rights to a healthy dark-sky environment. Consequently, where official protection of public dark-sky interest does not exist, the assessment and management of outdoor light pollution are too complex for all relevant stakeholders to understand and as a consequence, are rarely carried out in coordination with public environmental interest. In principle, if the official protection of public environmental interest is to be reformed in English legal system, it would help address various concerns of public environmental interest which is that the English law might require environmental agencies and local authorities to take adequate and coordinated regulatory control to reduce all elements of outdoor light pollution, particularly where there are several risks that non-environmentally friendly or inappropriate lights pose to human health, the environment, astronomical dark-sky heritage, energy, and other relevant factors.

Secondly, some foreign jurisdictions delegated main contexts of light pollution through representing the first steps toward establishing the single definition in their light pollution rule. For example, single legal definition of light pollution (Contaminació

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and amenity with the neighbours' right to enjoy their own property. See O' Donnel, T. and Gates, L., *Getting the balance right: A renewed need for the public interest test in addressing costal climate change and sea level rise*, available from http://www.uws.edu.au/__data/assets/pdf_file/0020/520814/Getting_the_Balance_Right_ODonnell.pdf accessed 30 March 2015.

[726] Increasing public awareness of and appreciation for public dark-sky interest has been reflected a profusion of various foreign light pollution laws. See Sovick, J., 'Toward an Appreciation of the Dark Night Sky', *Protecting dark skies*, 2001 4 (18), pp 15-19.

[727] European Commission Directorate-General for Research and European Cooperation on Scientific and Technical Research, *COST 341 Habitat fragmentation due to transportation infrastructure in Spain*, available from http://www.iene.info/wp-content/uploads/COST341_NationalReport_Spain_SummaryUK.pdf accessed 30 March 2015.

lumínica), as defined by the *Catalonian Law 6/2001, on Environmental Regulation of Lighting for the Protection of the Nocturnal Environment (Llei 6/2001,de 31 de maig, d'ordenacióambiental del'enllumenamentper a la protecciódel medi nocturn)* [728], is also applied to key elements of light pollution to the extent it is necessary for an understanding of the main term of light pollution within the Catalonia administrative regional jurisdiction, including where appropriate the use of regional measures. The single legal definition of light pollution, therefore, is entirely familiar, which is critical as all dark-sky interest protection measures are built around the definition of light pollution. Any adverse effect of artificial light including all key elements of light pollution is able to be defined by legislators and policy makers. The core aspects of light pollution control are generally defined by reference to the same criteria used in the legal system. If this is an opportunity to simplify the certain elements of light pollution by having the single legal definition in the written statute, it can distinguish between meanings of various applications to key elements of outdoor light pollution (glare, sky glow, and intrusive light), in all of the jurisdiction requires light industry stakeholders to approach outdoor light pollution in necessary stage processes. While there are direct benefits in the measuring of dark-sky environment performance as it will benefit from environmentally friendly lighting and efficient lighting, gain a better understanding of key elements of light pollution to the risks of non-environmentally friendly or unnecessary lighting, which will help strengthen legal awareness in the English legal system, a single legal definition of light pollution has not been derived from the English legal system.

Thirdly, the precaution of light pollution enables rapid response in the face of a possiblity to protect the dark-sky environment. In particular, where development of illuminating engineering technology or architectural light design does not permit a complete assessment of the risk[729], recourse to precautionary approaches may, for

[728] Parlament de Catalunya, *Llei 6/2001, de 31 de maig, d'ordenació ambiental de l'enllumenament per a la protecció del medi nocturn*, Parlament de Catalunya, 2002, pp 1-35.

[729] Other environmental risks may include the implementation of new light technologies to perform poor design of high-light-pollution lighting devices and the optimisation of lighting conversion scenarios in order to increase light pollution for some specific site. See Aubé, M., Franchomme-Fossé, P., Robert-Staehler, P., and Houle, V., *Light Pollution Modelling and detection in a heterogeneous environment:*

example, be used to stop excessive or intrusive lighting from the sources of non-environmentally friendly lights likely to be hazardous.[730] For example, in recent years scientists who have been investigating the harmful impacts of blue-rich lighting have developed various precautionary approaches with regard to the use of blue-rich light[731] through the adoption of precautionary principle to take necessary or proportionate steps to avoid foreseeable harm caused by the outdoor light pollution from outdoor blue-rich light facilities.[732] Therefore, the environmental and planning rules need to take on board colour temperature, either because of the existing scientific evidence, or because of the precautionary approach. This means English law may be provided by implying terms into the linkage between the environmentally friendly lighting practices and the precautionary metrics. In effect, therefore, the right to a healthy dark-sky environment may take effect as terms of controlling outdoor light pollution. Additionally, a precaution, protective, and sustainable environment might be integral to the full enjoyment of a wide range of public environmental interests. When the energy efficiency technology raises threats of harm to human health or the night environment, precautionary metrics should be taken even if some cause, risk and effect relationships are not fully termed scientifically. For examples, while some research findings concerning LEDs outdoor lighting and blue-rich white outdoor light wavelengths shorter than about 500 nm seem to support a possible role of human well-being

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Toward a Night Time Aerosol Optical Depth Retrieval Method, Proceeding of SPIE 5890, 2005, pp 1-3.

[730] Europe Direct, *The precautionary principle*, available from http://europa.eu/legislation_summaries/consumers/consumer_safety/l32042_en.htm accessed 30 March 2015.

[731] Falchi, F. et al, 'Limiting the impact of light pollution on human health, environment and stellar visibility', 2011 *Journal of Environmental Management*, available from http://dynamics.org/MAUI_NIGHT_LIGHTS/ARTICLES/Falchi+Cinzano++Haim_limiting.2011.pdf accessed 30 November 2014.

[732] The precautionary principle has been most recently considered in relation to harmful blue-rich light pollutants. Although it is officially accepted that the right to a healthy dark-sky environment can exist as an adequate condition of life, there remains doubt as to the parameters of public outdoor blue-rich light within which such rights to emit blue rich colour temperature light sources for exterior light can subsist. Where a right is granted to public illumination or public lighting anywhere on large plot of urban brightness areas, such as LED street lighting and LED security lighting, then it can be critically argued that the Government and their local authorities are left without any reasonable use of harmful outdoor blue-rich light. So, the use of outdoor blue-rich lights needs to be banned outright for human being reasons by English environmental and planning legislation.

disturbance[733], using the appropriate metrics to effectively drive the precautionary action may be a better indicator of acting to protect public health and the night environment.[734]

Fourthly, the existing *Clean Neighbourhoods and Environment Act 2005* has not officially established certain degrees of light pollution and asset classifications of minimum standards for the light pollution prevention[735] in the English legal system. In recent years, the recognition of the links between light standards and the use of International System of Units (SI) in illuminating engineering has been increased through the legal awareness of obtrusive light limitations for outdoor lighting installations, with the minimum amount of outdoor lighting measurable under the English soft law regarding illuminating engineering practices[736], for example, the *Institution of Lighting Engineers Guidance Notes for the Reduction of Obtrusive Light*[737] and the *British Astronomical Association's Campaign for Dark Skies Lighting guidelines*.[738] As density of light flux in an outdoor area or areas assessed with calculations made by, or on the basis of illuminating engineering, therefore the metrics

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[733] The emergence of blue-rich white light (light between 460 and 480 nanometres) as a major environmental issue has a significant impact on human health and the night environment and it is predicted to increase due to efficient LED technology of the outdoor higher-than-average power densities, increasing urban lighting development and changing urban lighting landscapes that has the potential to divorce several environmental goals and put the lighting industry on a collision course with those aiming to design healthful public spaces. See Schuler, T. A., 'Illumination Blues: The Coming Conflict between Two Separate Environmental Issues', *Landscape Architecture Magazine*, July 2015, p 38.

[734] Goldstein, B. D. and Carruth, R. S., 'Implications of the Precautionary Principle for Environmental Regulation in The United States: Examples from the Control of Hazardous Air Pollutants in the 1990 Clean Air Act Amendments', 2003 (66) *Law and Contemporary Problems*, available from http://scholarship.law.duke.edu/cgi/viewcontent.cgi?article=1300&context=lcp accessed 30 November 2014.

[735] To contribute to the public well-being by establishing minimum standards for outdoor light quality, the minimum outdoor lighting requirements should be clear and detailed information that is publicly available on statutory requirements in England.

[736] Certain standards will have then a better understanding of how the lighting measurements are legally made, and the implication of some value of light level. See Hiscocks, P. D., *Measuring Light*, Ryerson University, 2011, p 4.

[737] Institution of Lighting Engineers, *Guidance Notes for the Reduction of Obtrusive Light*, Institution of Lighting Engineers, 2005, pp 1-4.

[738] British Astronomical Association Campaign for Dark Skies, *Lighting guidelines*, British Astronomical Association's Campaign for Dark Skies, available from http://www.britastro.org/dark-skies/pdfs/CfDS_guidelines.pdf accessed 30 March 2015.

the soft law take to minimise light pollution can have a wide array of direct environmental and efficient energy benefits as well as making light pollution more measurable. In several foreign jurisdictions, a growing legal awareness of the illuminating engineering metrics, for example, lux and footcandles, with its greater focus on certain measurable degrees of outdoor lights, means that the implication of the outdoor lighting measurement becomes all the more important in minimising outdoor light pollution and maximising outdoor light efficiency. The amount of outdoor light metrics included in illuminating engineering, measured in certain SI units, is practical to verify from a simple list of SI units, and requires specific degrees of outdoor light. Therefore, the certain metrics of light pollution control leaves the maximum flexibility for the outdoor lighting practitioners, while at the same timekeeping a cap on the total amount of light used.[739] This makes for a stronger support that they have compulsorily committed these particular light metrics to their light works in the light pollution control rules. The aim of the *Act 2005* is not to assist environmental agencies, local authorities and people in dealing with excessive or obtrusive lighting matters brought to their attention involving a measurable degree of non-environmentally friendly illumination prohibited under the English law. This means that environmental agencies, local authorities and people are not able to calculate the certain degrees of all major light pollutants through measuring minimum standards to protect human health and the night environment (i.e. the certain form of the metric illuminating system of the non-environmentally friendly or inappropriate outdoor light intensity in Cd (Candela), outdoor luminance in Cd/m2, and outdoor luminaire flux). The metric of outdoor light pollution can either be determined by SI unit lighting measurement. The measurable metric of outdoor lighting usually makes use of assessment and evaluation on dark landscapes, district brightness areas as well as the boundary of two areas. In order to assess obtrusive light from outdoor lighting fixtures and design, the measurable metric also determines the degree which best indicates the impacts on the night environment. It is one of the key factors that legislators and policy makers may consider before

[739] Law Reform Commission of Saskatchewan, *Background Paper: light pollution abatement legislation*, available from http://lawreformcommission.sk.ca/LightPollutionAbatementBP.pdf accessed 30 March 2015.

proposing use the environmental zoning for outdoor lighting control within their urban development plans and zoning regulations for rural dark-sky conservation areas. Again, the measurable metrics are useful when considering how light pollution is shared around a local population and how light pollution measurements could be used to limit light pollution around both urban and rural areas. If it is somewhat difficult to compare between environmentally friendly light and light pollution from different metrics of illuminating engineering, the English law should be used to address certain legal metrics for areas where outdoor light emissions from non-environmentally friendly or unnecessary lights are determined to be significant contributors to the debasement of dark-sky and nocturnal quality.

Fifthly, providing opportunities for you to enjoy the healthy night-time environment are covered by two sets of law. One is concerned with nocturnal conservation areas enforcement and the other with astronomical dark-sky park protection. The two legal concerns are slightly different: although they both address the same light pollution control for astronomical or ecological purposes, they use different dark-sky concepts and lead to different outcomes. Some populations of rare natural habitats, wild fauna and flora have been protected and are considered to be of ecological interest, following standards given in the current legal frameworks under the *Wildlife and Countryside Act 1981* and the *Natural Environment and Rural Communities Act 2006*. However, the English conservation areas legislation, such as the *National Parks and Access to the Countryside Act 1929*, the *Planning (Listed Buildings and Conservation Areas) Act 1990* and the *Environment Act 1995*, does not consolidate certain enactments relating to light pollution control in respect of both astronomical and ecological zones for exterior lighting control[740], for example, the restrictions regarding lighting practices that are essential to intrinsically dark landscapes in rural national parks areas (i.e. the rural areas of Northumberland National Park[741] and the Kielder Water & Forest Park[742]) and low

[740] Stone, E. L., *Bats and Lighting: Overview of current evidence and mitigation*, University of Bristol Bats and Lighting Research Project, 2013, pp 14-15.

[741] Northumberland Tourism, *Introducing the Northumberland International Dark Sky Park*, available from http://www.visitnorthumberland.com/darkskies accessed 31 March 2015.

[742] Kielder Water & Forest Park, *Dark Skies at Kielder Water & Forest Park*, available from http://www.visitkielder.com/play/discover/dark-skies accessed 31 March 2015.

district brightness landscapes in urban conservation areas (i.e. the English Town Conservation Areas). This research suggested that the English legal system should set out the national regulatory framework as an important tool in recognising important concepts, such as astronomical light pollution and ecological light pollution are often used in both conservation areas and astronomical dark-sky parks. They are important in providing a number of regulatory frameworks with certain healthy dark-sky environmental zoning for minimising outdoor light pollution at night in English conservation areas and dark-sky parks. The relationships between nocturnal conservation areas management and dark-sky areas management, and the growing threats they face, will draw increasing attention from English legislatures and policy makers in the future.[743] For this reason, in the field of sustainable planning development, the English law should involve a set of stakeholders, all influenced by their own roles, duties, responsibilities, and interests and who are part of one or more joint astronomical dark-sky and nocturnal environment protection for the conservation of protected areas in England. [744]

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[743] Recognised for the stakeholder's roles in protecting dark-sky quality and for their importance as nocturnal wildlife habitat, and reinforced by financial incentives from government and local authorities, conservation buffers are able to become a familiar component of many astronomical and conservation landscapes. Additionally, astronomical observatory tourism and nocturnal ecotourism must be willing to place dark-sky conservation a head of economic profit in many instances, which means increasing the flow of tourists and local money. See Conservation Technology Information Center, *Economic Benefits with Environmental Protection*, Conservation Technology Information Center, 2002, pp 1-28. and see also Buchsbaum, B. D., *Ecotourism and Sustainable Development in Costa Rica*, Master of Public and International Affairs Paper, Virginia Polytechnic Institute and State University,2004, p 24.

[744] Nocturnal ecotourism and astronomical observatory tourism are widely, but perhaps uncritically, accepted as one strategy to provide dark-sky conservation, socio-economic, and forestry conservation benefits at both local and national levels. The major underlying assumption of them is that visitors can provide the necessary economic incentives to achieve local dark-sky conservation and development. They generate revenue which will be used to protect and conserve the nocturnal wildlife and habitats that draw visitors to astronomical and nocturnal sites at night. Notwithstanding astronomical observatory tourists visiting nocturnal ecotourism and astronomical observatory sites have a risk of being injured by nocturnal wildlife attack at night. Zoning for nocturnal ecotourism and astronomical observatory tourism may conform to the regulations for the conservation of astronomical and ecological conservation sites found in conservation law, including, but not limited to, tourist safety law. See Brandon, K. and Margoluis, E., The Bottom Line: Getting Biodiversity Conservation Back into Ecotourism, 1996 (99) *School of Forestry and Environmental Studies Bulletin Series*, available from http://environment.yale.edu/publication-series/documents/downloads/0-9/99brandonetal.pdf accessed 30 March 2015. and see also International Foundation for the Conservation of Wildlife and Food and Agriculture Organization of the United

Sixthly, the amount of different outdoor light pollutants from a set of exempted premises under the *Clean Neighbourhoods and Environment Act 2005* that are emitted to the urban brightness areas and intrinsic dark-sky conservation landscapes not only lead a number of negative environmental impacts, but also cause have negative effects on different performance characteristics of exempted premises themselves. Whilst the *Clean Neighbourhoods and Environment Act 2005* excludes some sources of light pollution from outdoor lighting for safety and security reasons, such as airports, goods vehicle depots, lighthouses, railway and bus stations, defence premises and prisons, it does not mean that these sources of lights are environmentally friendly or appropriate illumination.[745] At the same time, a number of constraints and challenges of the exempted lighting premises are increasingly apparent in opposition to the light pollution control efforts. This research recommends that there is currently an imbalance between the use of exempted lighting premises and the control of outdoor light pollution whereby public service bodies who emit some forms of inappropriate or unnecessary lights can escape their environmentally friendly responsibility and energy saving awareness by polluting the exempted light pollution. In this situation, while the English light pollution law disadvantages the public service bodies that need to provide the management of the night environment when they need to protect the English night sky and increase their outdoor lighting facility performance for their safety and security reasons, This research strongly recommends that an appropriate balance between the outdoor lighting for public interest reasons and the control of outdoor light pollution should offer the important ability to minimise significant amounts of outdoor light pollutants and consequently improve healthy dark-sky quality in England, for example, public service bodies may find they are dealing with what is, effectively, the energy efficient lighting facilities with no excessive or obtrusive lighting emission for their environmentally friendly or appropriate lighting practices in the future.

Nations, *Human-wildlife conflict in Africa Causes, consequences and management strategies*, FAO Forestry Paper 157, 2009, p 15.

[745] For example, the expansion of upward light near to and above the horizontal from airport lights at night is able to emit extreme orange smog (sky glow) of sodium vapour illumination that comes from various aviation brightness facilities (i.e. airport car park lights, runway approach ramp lights, visual approach slope lights, and taxiway lights).

In conclusion, the current the *Clean and Neighbourhoods Act 2005* as a main English domestic legal instrument against light pollution lacks a range of coherent light pollution provisions. In considering whether a regulatory tool is an appropriate environmental and planning mechanism, there is a need to extend all aspects of light pollution control for outdoor lighting practices. In order to ensure light pollution law in England supports all key elements of light pollution which is fit for the urban lighting expansion and the dark-sky environment conservation, the English legislature and policy makers should propose to modernise all parts of the existing environmental and planning legislation which are outdated. So, this research will be looking forward to a consideration of analysing lacunae in existing English light pollution law that would benefit from further English environmental and planning law reform, following the need for setting new regulatory measures to control outdoor light pollution analysed critically by our recommendations.

Below, this research critically analyses a comparative law approach as a tool for reforming English light pollution law which can be particularly useful to the English legislatures and policy makers who need to be ensured that the further statutory reform to simplify and clarify key elements of light pollution control would benefit from comparative law. A comparison of the environmental regulatory framework on the light pollution control in the EU jurisdictions, the U.S. jurisdictions, and other relevant domestic jurisdictions specifically provides the common or joint elements of light pollution control mechanisms necessary to deliver efficient domestic light pollution control in England. It also provides effective ideas of harmonising environmental and planning law across international and European jurisdictions to ensure minimum dark-sky environment protection and urban lighting development requirements at both international and European levels.

9.2 Lessons that can be learned from other jurisdictions

This comparative law research sets out main reasonable illustrations of the similarities and differences of international, European and domestic legal contexts for reforming the English light pollution control legislation in the future, such as international legal

measures, European legal measures, domestic law origins, domestic regulatory bodies with responsibilities for the dark-sky environment, domestic light source standards, domestic lighting practice standards, domestic urban development zoning for outdoor lighting control and other relevant exemptions of domestic light pollution requirements.[746] While the English legislatures and policy makers have not considered adoption of all comprehensive aspects of environmental and planning law, this research suggested three important alternatives for providing further regulatory reform to the English light pollution regulations in fulfilling domestic environmental, energy and planning objectives at both national and local levels.

First of all, we suggested that the English legislatures and policy makers should adopt necessary or proportionate elements of environmental and planning law that can be used as specific elements of English light pollution control which indicates a number of regulatory instruments with certain light pollution control characteristics as mentioned in Chapter 5. They should apply general principles of environmental and planning law in taking specific measures designed to protect and conserve the English dark-sky environment, to provide for their sustainable energy development and to minimise the impact of outdoor lighting activities on the rights to healthy night environment. For example, a simplified measure of market-based incentive approaches should confidently be used to allow light pollutants (such as manufacturers, importers, distributor, retailers and consumers) to address the environmental challenges posed by increasing complementary approaches of reducing potential harms to the environment where pollution is to be borne by the originators. All lighting stakeholders should be bound by economic incentive rules[747] about how light pollution reduction should be persuaded by market-based instruments if legal measures can activate the national governments or their local authorities to formally address necessary activities, systems, schemes and

[746] Bernstein, H., 'The Strength and Weakness of Comparative Law by Bernhard Grobfeld', *American Journal of Comparative Law*, 1992 1 (40), pp 261-263.

[747] Considering a light pollution law and economics approach allows choosing among economic instruments that have an incentive objective (the deterrence of dark-sky quality degradation) and a remedy objective (the comprehensive treatment of night environment damages). See Germani, A. R., *Environmental Law and Economics in U.S. and E.U.: A Common Ground?*, Discussion Paper 45, 2004, pp 1-20.

programmes by proposing an appropriate market-based approach[748], allowing environmental remedy where monitoring of each polluting action is difficult and where several polluters contribute to the outdoor brightness levels and misdirected lighting at both industrial and housing levels.

Next, the English legislatures and policy makers should apply necessary or proportionate elements of both international and European law to reform the English domestic light pollution law.[749] Introducing European law would have raised a critical question about what the English law will bring together necessary principles from international and European regulatory frameworks, and will also include the relevant principles from environmental law. The best answer was thought to be improving and developing the current regulatory measures, particularly the exterior lighting standards and the criteria for outdoor light products. Therefore, the English law is able to adapt the necessary elements of international and European law, which aims to integrate outdoor light pollution control law by replacing appropriate provisions with overarching necessary principles. For example, the existing EU law in eco-design of energy-related products (*Energy-related Products Directive 2009/125/EC (ErP)*) imposes different

[748] Questions may be raised as to whether corporate accounting for environmental activity remains in its infancy while the polluter-pays principle has prompted the introduction of financial and market instruments to promote responsible light pollution control behaviour. For example, environmental considerations, wherever essential, will become an integral part of loan agreements for new construction project. They may be one of a number of so-called financial instruments introduced to influence behaviour in relation to environmental light pollution. The increasing concern at the impact of outdoor light pollution is able to lead to efficient lighting fixtures and sustainable lighting practices that will be the use of procedures to assess the environmental impacts of financial institutes' lending programs and projects. They may seek to strengthen procedures for systematic dialogue with their borrowers on environmental light pollution issues during the programming cycle and before project-specific identification. See Egede, T. and Lee, R., 'Bank lending and the environment: not liability but responsibility', *Journal of Business Law*, 2007 November, pp 868-883. and see also Kennedy, W. V., *EIA and Multi-lateral Financial Institutions*, European Bank for Reconstruction and Development, 1999, pp 3-4.

[749] The non-environmentally friendly or inappropriate lighting practices should be considered by comparative international and European legislation when the UK becomes an existing party of primary and secondary sources of the international law or a Member State of European regulatory regime that identify regulatory measures to be taken by the UK to control their emissions of outdoor light pollutants: although they both international or European regulatory regimes address the same Environmental protection conduct, they use some different concepts of European regulatory harmonisation and international regulatory integration, and lead to varied outcomes of comparative law as mentioned in Chapter 6 and Chapter 7.

obligations on modern light source standards depending upon Member States' adoption and implementation where Member States and other relevant light stakeholders (i.e. manufacturers, producers, service providers, suppliers, wholesalers, distributors and retailers) will have the same regulatory roles and legal obligations wherever they are in EU legal regime. The EU regulatory frameworks and Member States' regulations aim at reducing the environmental impact of light-related products, including the energy consumption throughout their entire life cycle by the labelling to raise the awareness of consumers and the energy efficiency requirements as an economic incentive or market-based instrument of the European Union regime. The UK as an EU Member State should adopt both general legislation designed to reducing the environmental impact and inefficiency energy impact of light-related products and they also adopt specific legislation designed to limit light pollution throughout their outdoor light source requirements. Again, to benchmark the levels of pollutants with environmental and astronomical objectives in England and European countries, the harmonisation of appropriate metric to assess excessive levels of artificial light annoyance and sleep disturbance may fall within the EU law, which is a large and varied set of European environmental and planning rules. One possible approach for these environmental concerns might be to abandon several limitations on the EU law. The concepts of identifying environmental quality metrics, finer degrees of resolution, reliable measurements for comparison and measurable levels of outdoor light may be merged into a single directive.

Finally, a comparison of similarities and differences of domestic light pollution control measures, such as law origins, regulatory bodies with responsibilities for the dark-sky environment, light source standards, lighting practice standards, urban development zoning for outdoor lighting control and other relevant exemptions of light pollution requirements, is clearly easy for all domestic jurisdictions to apply necessary or proportionate criteria of outdoor light pollution control to their national or local jurisdictions where they have experienced domestic outdoor light pollution in their non-environmentally friendly or inappropriate exterior lighting practices. It has examined the influence of soft law within the professional astronomical bodies as well as

illuminating engineering bodies on standard-setting in domestic light pollution frameworks. Central or local governments from several jurisdictions, for example, U.S., France and Canada, have already accepted all the key harmonised aspects of the soft law and intend to implement these in their national and local jurisdictions, with the aim of reducing all key elements of light pollution and combating non-environmentally friendly or inefficient outdoor lighting practices. Some domestic jurisdictions are, however, sometimes not only regulatory but are also intended to develop their own regulatory measures to prevent some particular forms of light pollution, for example, the Slovenian legal system significantly sets out a clear set of aspects governing outdoor illuminating façades of the cultural monuments and historical buildings. Some domestic jurisdictions also intended to develop their own legal actions against the light pollution due to the some key forms of their domestic non-environmentally friendly or inappropriate lighting practices, for example, artificial light that is allowed to illuminate or intrude upon areas not intended to be lit is considered to be a statutory nuisance in English and French legal systems. The use of both statutory instruments and written regulatory mechanisms in soft law and hard law has presented a legal challenge to the traditional sources and the joint functions of domestic light pollution law in global legal system. In response to the English domestic problems, this research strongly recommends that comparative law should be applied more potentially to provide a number of completely shared legal principles or to provide a range of common light pollution control standards with the selection of providing the latest lists of references of specific standards for environmentally friendly or appropriate lighting practices in cases of light pollution control; it is an agent of change and of harmonisation between different domestic jurisdictions and their legal contexts as mention above. Comparative light pollution law can be a term effectively used to refer to a range of major similarities and differences between the unique English legal system and the various legal systems that share both common regulatory approaches to environmental and planning regulations with other jurisdictions and some aspects of the environmental and planning law.

While comparative law can be issued by different forms of comparative principles and

frameworks, such as basic principles, international law, regional law or domestic soft and hard laws as mentioned above, the role of comparative law methodology can serve to facilitate the adoption of improvements in areas of domestic light pollution control in England. In deciding this, the key critical question to ask is how can comparative law have an important role to play in reforming a number of potential regulatory functions for the light pollution control field in England? Answering this question in the affirmative, this research suggested that the English legislatures and policy makers should study how foreign light pollution laws (i.e. soft law and hard law) approach and resolve common light pollution problems. As part of a wider approach to reforming English light pollution law, the similarities of the common solutions to the same problems are assessed by comparing the foreign regulatory requirements and their exemptions for which the common elements of light pollution control law have been adopted and those for which the common regulatory mechanisms have been used, such as light source standards, lighting practice standards, urban development zoning for outdoor lighting control and other relevant exemptions for safety and security reasons.

Although the comparative law methodology has argued that it would be wrong to create the making of comparison on English and foreign light pollution law, particularly when it is considered that there are such limitations in combining the comparative law and English law reform as mentioned in Chapter 8, this research recommends that any common regulatory mechanisms from comparative foreign laws should be targeted at the general situations where it is legitimate to approach common or joint light pollution problems from both foreign and English legal systems, rather than apply concepts of light pollution control to specific foreign legal systems or particular English legal system.

This research summarised that the lacunae in existing English light pollution law and the need for setting new regulatory measures to control outdoor light pollution left by the comparative legal studies. The legislatures and policy makers should consider the requirements of the foreign light pollution laws, and refer to the way that legal aspects of the international and foreign light pollution laws should be adopted and incorporated into English statutory law.

9.3 Opportunities and challenges for light pollution law reform in England

England faces a range of environmental and planning challenges. Light pollution is becoming an increasingly important focus of environmental and planning interest for numerous astronomical and environmental professional bodies, but light pollution is also becoming an increasingly important focus of environmental and planning interest for some English legislators and policy makers. The statutory nuisance from artificial light is currently designed to limit this by restricting some circumstances of light intrusiveness that become a statutory nuisance, but they have not yet established all aiming targets for the protection of public dark-sky interests in England. A wider look at the full problem of light pollution should be addressed with environmentally friendly or necessary lighting practices. A look at them can identify the major challenges for the light industry stakeholders (i.e. general public, businesses, industries, commercial retailers, and public sectors) dealing with all aspects of environmental and planning law and describe a set of specific measures where specific circumstances of each light pollution problem required the regulatory measure enforcement and the stage process cooperation of all light industry stakeholders. An inadequacy of applying all useful environmental and planning principles to the English regulatory mechanisms is the most significant barrier to harmonised light pollution control in the English legal system.[750] Success of using the tools of environmental prevention to reduce misdirected light emissions and excessive levels of illumination where artificial light at night causes harm will depend on the establishment of mechanisms and approaches that incentivise the use of outdoor lights for effective lighting sustainability and ambitious systematic action of the light product safety standard.[751]

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[750] Campaign to Protect Rural England, *Ministers miss opportunity to tackle lighting nuisance*, available from http://www.cpre.org.uk/media-centre/news-release-archive/item/2889-ministers-miss-opportunity-to-tackle-lighting-nuisance accessed 31 March 2015.

[751] The main idea of systematic light pollution control is the linkage between the well-being of the public dark-sky environment and the well-being of future economic, social and environmental interests. Responses to address light pollution, both public dark-sky protection and healthy night environment, are linked to a balancing act between the economic, social, and environmental awareness in relation to regulatory light pollution control. See Wu, B. and Wong, H., *Visualisation and Analysis of Light Pollution: A Case Study in Hong Kong*, ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences - XXII ISPRS Congress, 25 August – 01 September 2012, Melbourne,

The previous chapters of this research have been investigating with regard to the foundations of taking a high level view of how best to achieve regulatory light pollution control at international, European, national and local levels and, also, possible ways to minimise all elements of outdoor light pollution.[752] However, the several ways of reforms remain too broad and the critical question remains over how to reform the English regulatory mechanisms to provide better and more modern lighting requirements, particularly in relation to outdoor lighting practices and light product standards under the English law.

When facing light pollution problems in England[753], the Government should keep up to date its regulatory mechanisms. A range of English regulatory reforms proposed derive from three main opportunities of this comparative law research. First, English regulatory light pollution requirements in the future should give several ways to follow the adoption of appropriate regulatory functions of light pollution laws in global contexts. The comparative law not only considers regulatory tools that should be designed to address all types of light pollution risks through choosing and applying to make sure that comparative regulatory functions[754] from several jurisdictions will be effective in England, but also deliver a coordinated and globalised response to unacceptable risks to all elements of outdoor light pollution. For example, the comparative regulatory illuminating engineering standards for environmentally friendly lighting may be formally adopted by the Government and light industry stakeholders.

Australia, pp 1-6.

[752] For example, light obtrusiveness from the outdoor light premises, reduce urban atmospheric illuminated smog to increase natural dark-sky view, improve naked eye visibility through glare reduction for safety reasons and reduce impacts on nocturnal ecological systems.

[753] Royal Borough of Kensington and Chelsea, *Examination of the Partial Review of the Kensington and Chelsea Core Strategy: Basements Publication Planning Policy Matters, Issues and Questions for Examination*, available from http://www.rbkc.gov.uk/pdf/REP-283-001%20Brompton%20RBKC%20EiP%20Basements%20Matters%20%20Issues%20BA.pdf accessed 31 March 2015.

[754] The functional method of comparative law is able to apply equally to various disciplinary approaches if we replace solutions of light pollution with observations of all effects. For example, Chilean economists were satisfied with finding three different models of financial taxation and economic stimulation; they were satisfied with three models of outdoor light pollution control – energy waste control, astronomical tourism and economic interest – as causes for Chilean economic progress. See Smith, M. G., *Controlling Light Pollution in Chile: A Status Report*, available from http://www.noao.edu/ctio/light_pollution/english/iaupaper.pdf accessed 31 March 2015.

Global illuminating engineering standards are able to examine inappropriate or unnecessary lights at night, with particular focus on misdirected light control and the zoning for outdoor lighting control through illuminance measurable requirements in outdoor areas. Although light pollution control standards from these techniques differ in many ways from prevention and prohibition of outdoor light pollution, they nonetheless offer legally binding criteria for the use of global standard approaches in dark-sky environment protection, such as full cut-off outdoor light shielding, switching off outdoor lights during the curfew hours and a ban on outdoor use of upward light beam displays. These standards may be the outcome of comparative studies carried out in global dark-sky cooperation with and after applying elements of illuminating engineering techniques and enforcement of the light industry stakeholders.

Second, if, in contrast, the Government does not follow the common standards for environmentally friendly lighting or the English legal system does not take into account the following needs of global light pollution control as explained above, the English legal system can make it possible for new legal reform under existing principles of environmental and planning law in order to control and assess outdoor light pollution at night. This means that the Government and relevant light industry stakeholders may set their own innovations in environmental law and policy during which it has been effectively applying necessary or appropriate elements of environmental and planning law with bearing any full or partial adoption of the new legal methods. These innovations may represent a departure from the legal measures or regulatory incentive mechanisms in the English legal system. Light industry stakeholders may contribute to better requirements and the consequences of regulatory enforcement could pose more threats to light industry stakeholders than current global light pollution standards. For example, as with the assessment of illuminated signs and billboards for local tax purposes, the regulatory approaches to a range of tax incentives (e.g. well-designed environmental tax incentives are able to encourage the operator or possessor of the premises on which the illuminated sign or illuminated billboard is located to operate in a more environmentally friendly lighting way) can make the extra effort of calculating their extra tax rate liability by increasing the assessable price of the lighting billboard

tax.[755] Therefore, billboard light fixtures and types of illuminated billboard should be considered in assessing billboard tax payments. If an illuminated sign is shielded to prevent any light to be directed at oncoming traffic in such brilliance as to impair the vision of any driver or the source of billboard light is not directed upon any part of a residence or into any area zoned for residential use, the operator or possessor as taxpayers may not pay extra tax rates for light pollution control. However, introducing a comparative law method would have predictable questions, and raise a critical question about what legal measure of light pollution control should England which has experienced non-environmentally friendly lighting practices, be entitled to? The best option was thought to be improving and simplifying current English law. So, there are two main choices between the use of comparative terms of foreign light pollution control methods instead of self-English efforts and the use of a English multi-case analysis, instead of the traditional comparative law approach. Future English reforms would provide better resolution of light pollution issues, which bring actions on both, by following the wording of the international, European and foreign laws as well as developing a set of English only instruments of action to carry out sustainable lighting practices. The introduction of both actions is also regarded as an opportunity to better achieve globalisation and nationalisation of light pollution control. Additionally, it is better to start with a relatively narrow but principled approach to following global or foreign light pollution law and to expand the concept if necessary, rather than to start with no-effort or where nothing happens, and then find a number of pathways to develop with each implying necessary or appropriate legal doctrine may approach light pollution problems in England.

Finally, following this critical analysis of changes in response to new illuminating engineering technologies and economic incentive conditions and causes of the environmental light pollution problems, this research identifies the changes in light

[755] Environmental regulatory instruments can be classified according to two criteria: (i) whether they dictate how much to abate and what abatement outdoor lighting technology to use or simply create environmental tax incentives for light industry stakeholders to abate, and (ii) whether they require the regulator to monitor outdoor light pollution emissions. See Blackman, A. and Harrington, W., *The Use of Economic Incentives in Developing Countries: Lessons from International Experience with Industrial Air Pollution Discussion Paper 99-39*, Resources for the Future, 1999, p 2.

pollution regulation and regulatory approach needed to create more modern and effective legal methods, which agencies and authorities can implement or plan to introduce and/or which it may be proposing in the English legal system. Although this comparative law research discusses the possibility of applying necessary or appropriate elements of light pollution control in the English legal system, with similar or better standards of dark-sky protection, there is confusion in the best way to improve jurisdiction over light pollution control, due in part to a lack of emphasis in English legislation on taking all necessary regulatory approaches. Therefore, the Government should provide local authorities and light industry stakeholders with clearer and simpler stage processes to control non-environmentally friendly lighting and sustainable lighting practices and this will make the necessary stage processes more effective. As discussed in Chapter 8, this research makes further comments on the dark-sky conservation, particularly on the question of whether to extend the possible key stages in taking local light pollution protection into account in the local environmental and planning process. Certain stage processes should help to create local authorities' responsibility and a consistent level of integrated dark-sky preservation cooperation across England, reducing non-environmentally friendly lighting problems and creating more favourable perceptions of light pollution knowledge as well as an information overview of how efficient energy lighting practices and the spatial planning process can control light pollution strategically through the sustainable integration of social, environmental and economic considerations into English law. For example, the light industry stakeholders should be in place to assist in the successful planning, mitigation and control of local light pollution harms in England by providing a better opportunity to identify future strategic plans against other local light pollution premises to ensure the local environmental and planning process is earmarked at the appropriate time. The necessary functions of light pollution control may be exercised by environmental and planning authorities for a purpose connected with light pollution control.

This research strongly highlights the importance of clarifying a single coherent set of regulatory frameworks dealing with dark-sky quality assessment and light pollution control to improve the certainty of planned dark-sky conservation outcomes and

simplify mandatory steps specified by the provisions to ensure its accuracy or completeness. Although it is unclear whether local environmental and planning authorities are obliged to control sky glow or atmospheric smog in their local dark-sky atmosphere that are of national significance, they may be required to adopt specific regulatory frameworks which require local environmental and planning authorities to make a preliminary assessment of light pollution of all environmental zones for outdoor lighting control (i.e. intrinsically dark landscapes and district brightness areas), and then to identify urban and rural areas at potential risk of light pollution at night. For these potential risk areas dark-sky maps may be plotted to show the potential urban brightness areas and the adverse consequences arising from such a form of outdoor light pollution. Aims, measures and enforcement may then be developed to reduce potential light pollution impacts in strategic plans.

While seeking views on how this research can improve English light pollution legislation and replying to our critical questions will be set out in a legislative strategy for the area in question to ensure that enforceable measures and legal awareness are clear, the critical issue is linked to the three main opportunities of this comparative law approaches of how are basically links between three main opportunities in order to aim to minimise light pollution from various industrial, commercial and housing activities throughout the English legal system or in other words, all light industry stakeholders should have a legal connection to these three main opportunities. In particular, it is important to reconsider the joint cooperation and the integrated coordination when developing regulatory strategic directions. The future reforms to regulatory light pollution control should introduce a consistent and coherent link between the regulatory measurable requirements, new legal innovations and the preliminary strategic process. For example, if there are areas identified through preliminary dark-sky area assessments as areas of potentially significant outdoor atmospheric sky glow and light clutter in urban brightness areas, for which local strategic light pollution plans for outdoor light pollution control need to be prepared, a number of regulatory measures, such as full cut-off outdoor light shielding, switching off outdoor lights during the curfew hours and ban on outdoor use of upward light beam displays, may be created by the Government and

enforced by local authorities.[756]

Such light pollution impacts can result from increasingly excessive, obtrusive and inefficient lighting linked to the current problems with environmental and planning law, or from lack of clear responsibilities and overarching light pollution management in an official multilateral response, lack of formal strategic stage processes, as well as lack of consultations on how dark-sky conservation goals can be integrated into and addressed through national environmental and planning policies. Despite these studies demonstrating a number of significant links between legislative opportunities and possible outcomes, which are both methodical and have been observed in regulatory light pollution control studies using the unique comparative law method, the implementation of these requirements, innovations, and strategic procedures on light pollution law reform has been a major challenge for England, delivering very limited outcomes.

As already mentioned in the previous Chapters, among a range of legal challenges are the failure to determine three main opportunities for outdoor lighting practices, and the failure to associate between legislative opportunities and possible outcomes. If English regulatory environmental and planning frameworks are in some sustainable way seeking to change precautionary and preventive light pollution control practices for street lighting, security lighting, architectural lighting as well as facility flood lighting, it is hence arguably the context of current lighting practices in England amongst others that

[756] Local authorities may continuously monitor levels of light pollution predominantly from atmospheric sky glow emissions. This means that environmentally friendly or eco-friendly lighting sites may be placed in a range of dark-sky conservation locations according to local monitoring requirements. These light pollution control sites allow an overall view of light pollution levels in rural, urban, commercial, transportation parts of local areas. As all sites could be operated to defined dark-sky quality criteria and environmentally friendly lighting standards, each district or borough in England is able to augment their own monitoring results with comparable data from other local areas. Even though the UK Government is required by EU law to publish a number of environmental pollution indicators that can be used to assess whether its aims of sustainable development are being met, the official light pollution strategy has not been released and one of the headline indicators from previous strategic policies is not dark-sky quality or environmentally friendly lighting criteria. Modern illuminating engineering indicators designed to better reflect the effects on human health of long term exposure to all levels of light pollution have not officially regulated by the UK Government. See Chouhan, H., *Sussex Air Pollution Monitoring Network Annual Report*, Kings College London Environmental Research Group, 2013, p 14.

should be changed to ensure adequate dark-sky environment protection.

This research would enable the sharing of the contrast between recent energy conservation policy and possible light pollution control in England. Under commitments to reduce its energy consumption and carbon footprint in many large cities in England, the municipalities and localities have been changing its high & low pressure sodium lighting (i.e. the orange/yellow light from previous sodium based lantern) stock to energy efficient light-emitting diodes (LEDs) technology which will help towards achieving their energy saving performance.[757] However, the stronger blue-rich white light emission produced by LEDs white light technology, has been shown to have increased adverse impacts on the dark-sky environment and has a greater impact on nocturnal ecological systems and human health than other types of light technology.[758] Implementation of urban planning policies in England demonstrates that light pollution responses and awareness at both national and local levels cannot be effective in protecting people and the dark-sky environment. Again, the LEDs blue-rich white light could be a range of effective means of light pollution[759], including blue-rich white light technologies to lead non-sustainability for the use of illuminating engineering technology, as demonstrated by some failure to deal with a wide range of light pollution and other environmentally harmful issues.

The atmospheric orange smog that hangs over town and cities at night caused by misdirected upward lights shining into the sky, and is generally caused by orange high-pressure sodium-vapour (HPS) lamps or orange low-pressure sodium-vapour (LPS) lamps. However this research seems to make a critical analysis that, in the main, giving great savings in terms of energy and carbon reduction through retrofitting their existing

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[757] Leicester City Centre, *Street Lighting White Light Installation & Energy Conservation Programme*, available from http://www.leicester.gov.uk/your-council-services/transport-traffic/highways/street-lighting/white-light-energy-saving/ accessed 31 March 2015. and see also Nottinghamshire County Council, *Street lighting Reducing energy costs*, available from http://www.nottinghamshire.gov.uk/travelling/roads/road-design-and-maintenance/street-lighting/ accessed 31 March 2015.

[758] Chen, E., *Seeing Blue*, available from http://www.darksky.org/assets/documents/SeeingBlue.pdf accessed 06 February 2015.

[759] Harvard Health Publications, *Blue light has a dark side*, available from http://www.health.harvard.edu/staying-healthy/blue-light-has-a-dark-side accessed 06 February 2015.

street lights with new outdoor LED lights in England does not provide any greater dark-sky protection or any better environmentally friendly atmosphere than what is provided by the urban expansion of orange HPS and LPS light fixtures, and that the light policy at both national and local levels generally may be no better off by sky glow prevention from orange smog as well as blue-rich white smog. While overall trends in outdoor light pollution control are affected most strongly by the use of regulatory light pollution requirements as mention above, there is possible recognition that a stronger approach to LEDs energy efficiency provides the most effective way of increasing blue-rich white light emission in the night environment while at the same time increasing English people's chances of experiencing health effects that have been associated with exposure to blue-rich white light, such as human circadian sensitivity in relation to atmospheric blue-rich white smog.[760]

As explained above, regulatory approaches to be made to modern legal techniques may provide a great opportunity for balancing scientific illuminating engineering results with environmental, social and economic concerns.[761] By becoming better informed the Government and their authorities should reduce the night environment risks that they determine to be unacceptable through the establishment of the introduction, regulation and enforcement of environmental rights. As this research looked at the criticism that

[760] The economic approach to analyse the health care costs was used for many decades. Cost benefits studies for LED street lighting had been developed to evaluate the economic gain related to the expenditure for savings in energy with further savings in carbon emissions, but the LED lighting approach to analyse the health care costs have not been successfully used by England. It may largely rely upon a health approach to the valuation of these production losses in relation to non-environmentally friendly light at night. There is no study estimates the economic cost of the health impacts of light pollution from LED street lights; nonetheless, calculating the economic cost of the LED lighting impacts, and how much is due to light pollution from key elements of non-environmentally friendly lights, should require estimating the value of lost lives or lost quality of life in the case of illness. See Organisation for Economic Co-operation and Development, *The Cost of Air Pollution: Health Impact of Road Transport*, Organisation for Economic Co-operation and Development, 2014, p 11.

[761] In fact, several papers that employ separable effects for pollution and abatement/environmental maintenance, recognise this shortcoming and address it by imposing a non-negativity constraint that requires the environmental cost of emissions to dominate the benefit from abatement. However, there are no papers that include the direct environment and economic costs associated with the recommended application of LED street lights. See Pimentel, D., 'Environmental and Economic Costs of the Application of Pesticides Primarily in the United States', 2005 (7) *Environment, Development and Sustainability*, available from http://www.beyondpesticides.org/documents/pimentel.pesticides.2005update.pdf accessed 06 February 2015.

the dark-sky environment legislation fails to offer sufficient night environment protection, this research strongly suggested that there was a lack of several opportunities and scientific concerns likely to make environmentally friendly lighting purposes more complex and therefore unsuccessful, even where the current artificial light nuisance in England itself provides statutory law benefits for dark-sky environment protection. These are some loopholes which still remain in the English legal system.

Therefore, the Government could allow their legislators and policy makers to look more widely at modern illuminating engineering concerns across light pollution control as well as saving energy, and could also provide a range of opportunities to extend the scope of regulation to tackle all ecological issues and human health problems of light pollution concerns. Consequently, a range of light pollution responses and awareness should be established to promote three main opportunities in all contexts that support sustainable illuminating engineering technology, especially for outdoor light pollution control.

This comparative law research acknowledged that the Government and its environmental and planning authorities may play a significant role in considering the special challenges of comparing modern English light pollution law in the future. It looks at the important role of comparative law in offering far more protection of non-environmentally friendly or inappropriate lights than providing non-response and non-availability of the current English regulatory light pollution control. Comparative law also has a key role to play in delivering new principles of English light pollution legislation that are responsive to new light pollution harms as well as dark-sky conservation needs. Despite outdoor light pollution in England continuing to harm English people’s health and the dark-sky environment, English light pollution legislation has not yet been extended to include any illuminating engineering techniques and other relevant legal techniques that are effectively the regulatory control of outdoor light pollution.

The challenge is to make sure that the English light pollution provisions are effective enough to enforce, rather than obstruct, the legal action against non-environmentally

friendly or inappropriate lighting. This needs to be accomplished in a way that simultaneously protects, as far as possible, the intrinsically dark landscapes and district brightness areas, notably the diversity of sources of outdoor lights at night which cause results in the unnecessary emissions of outdoor light pollution. However, the challenge to the English legal system to create new and more efficient regulatory provisions generally relies on illuminating engineering technology, architectural lighting and other relevant practices of outdoor lighting through a comparison of the global, regional, national and local regulatory approaches to regulating the provision of light pollution control, which the comparative law methodology satisfactorily takes place on a global scale through the many available soft and hard laws from various jurisdictions.

In order to gain a better control of the integrated effects of light pollution and the ways their development might be coordinated with a number of significant pieces of existing written regulatory frameworks, principally statutory light nuisance, environmental and planning laws, and other relevant safety lighting legislation, this research strongly recommended that comparative law should examine a specific strategy for outdoor light pollution control or for multipurpose light pollution control that could be turned into English written law. They could do integrated work in developing a long-range strategy and they could better integrate all areas of outdoor light pollution, so that the legally binding practices would require continuous outdoor lighting control. For example, street lights, security lights, architectural lights, advertising and display lights, floodlights for commercial and industrial premises, sports ground lights[762] and parking facility lights are the main outdoor lights found to be polluting both urban district brightness areas and night sky landscapes in both foreign and English jurisdictions. These outdoor lights lead to impacts of unacceptable outdoor dark-sky quality or inappropriate night environment quality in England, such as astronomy, ecology, human health, energy and climate change, safety, consumer protection, and human rights. So, the environmental and

[762] An important question also arises as to the link between the sports player who uses lights for visibility at night and outdoor sports facilities where can all be sources of light pollution. The question is whether excessive or obtrusive light at sports ground would be a significant factor in player visual functions as well as race performance. See Sport England, *Design Guidance: Note Creating a sporting habit for life*, Sport England, 2002, p 10. and see also Lavallee, D., Kermer, J., Moran, A. and Williams, M., *Sport Psychology: Contemporary Themes*, 2nd edition, Palgrave Macmillan, 2012, p 101.

planning strategy should be designed to facilitate the task of advising national and local authorities, who bear the environmental and planning responsibilities of preventing outdoor light pollution by integrating all mandatory lighting standards in the enforcement of regulatory mechanisms. If a number of foreign requirements for light pollution control, intended to reduce inefficient and non-environmentally friendly lighting, are adopted by a growing number of national and local jurisdictions in the world, England may strategically follow the philosophy of foreign strategic requirements in that the same dark-sky or nocturnal challenges will be faced when people and the environment are in areas that have the same adverse light pollution impacts. This means that the Government should identify many lessons from the previous and current foreign light pollution lessons and that light pollution strategy should mark an important milestone in taking forward foreign lessons. The strategic programmes under future English law should clarify strategic responsibilities for tackling local sources of light pollution and set out a new role for lead local environmental planning authorities in bringing strategic partners together and making sure future strategic challenges get done.

In addition to sketching out the significant features of light pollution control mechanisms though comparative studies, the legal reforms aim to better protect more localities, deliver more benefits, and help avoid outdoor light pollution caused by excessive, obtrusive and inefficient lights, by encouraging education for environmentally friendly or ecological lighting technology to increase the best way of choosing efficient light products for public light fixtures and design at both school and higher education. Many nations and municipalities around the world are facing a range of challenges and potential threats to effective light pollution studies and a comprehensive presentation of environmentally friendly lighting awareness. Although this research does not specifically seek views on light pollution education and replies to our research hypothesis questions, making light pollution education more widespread is a big challenge that takes cooperation, coordination, time and knowledge. This challenge is linked to a few questions of how far dark-sky environment stakeholders will seek educational opportunities to take the step to enhance basic and advanced light

pollution studies at all stages of the state education system in England and how the education sectors promote their stated aim, which is to permit reasonable promotion for basic and advanced light pollution education in England. Answering these questions in the affirmative, this research suggests that the Government, educational sectors, local authorities and other relevant educational stakeholders should set out a more radical approach to reform which may answer these criticisms by dealing with designing to capture changes in attitude, awareness and knowledge.[763] For example, the local authorities may be committed to improving local dark-sky environment quality and raising awareness of the associated outdoor light pollution issues. They should allow educational actions for delivering a number of astronomical, environmental, and energy science based light pollution awareness, looking at both national and local levels via courses, programmes, curriculum and structures.

While many national and local jurisdictions in the world have their regulatory illuminating engineering techniques which deals with the same light pollution problems as England's groundless threat provisions, this research should follow foreign view things from educational resources to teach all levels of students about the connections between dark-sky quality, human health, night environment, nocturnal ecosystems, and other related scientific aspects, as well as various foreign legal actions students can take to protect human well-being and reduce local light pollution. For example, the source of outdoor light shall not be directed upon any part of a residence or into any area zoned

[763] Integration, coordination and multidisciplinary approaches in lighting should be encouraged by relevant agencies as an important element of sustainable light pollution control. As the problem of dark-sky quality touches on economic, social and environmental issues in England, the involvement of all light industry stakeholders, in particular those responsible for non-environmentally friendly light emissions, was very important to the success of the comparative law studies. For example, an electronic billboard can show bright animated images, but this is due to several environmental, health and safety problems with the modernisation of outdoor advertising. The light pollution law may use economic tools integrated into legal instruments to control light pollution from outdoor electronic billboard. If the source of brightness billboard is able to be directed upon any part of atmosphere or into any area zoned for public transportation use, the higher cost of the light pollution that results from the outdoor electronic advertising may make the activity less attractive to consumers and businesses. See European Environment Agency, *Environmental taxes: recent developments in tools for integration*, European Environment Agency, 2000, pp 8-9. and see also Organisation for Economic Co-operation and Development, *Environmental Taxation: A Guide for Policy Makers*, Organisation for Economic Co-operation and Development, 2011, pp 1-12.

for residential use or the source of outdoor light shall be shielded to prevent any light to being directing at oncoming traffic in such brilliance so as to impair the night visibility of any road users. Education for sustainable light pollution control enables people to develop the basic and advanced skills to participate in decisions about the way people use outdoor lights at night, locally, regionally and internationally, which will improve the dark-sky environment without damaging human health and wildlife.

Chapter 10: Conclusions

This research summarises comparative light pollution law research and extends critical analyses to determine how comparative law can have an important role to play in the field of reform of a number of potential regulatory functions for the light pollution control field in England, and to draw useful recommendations that are relevant for future law reform and for the Government and its lighting governing bodies.

10.1 Establishing a light pollution definition

Many approaches to light pollution forms have formally been included by legal definition and regulatory terminology. The several matters of common light pollutants, sources and characteristics generally depends on identifying the contexts of a legal definition whether the legal contexts of some common artificial light pollutants, their sources and classification are basically intended to achieve light pollution control, or whether various features were present in legal definition. It should make it easier for legislature, policy makers and other relevant light industry stakeholders to comply with rules, practice directions and campaigns under mutually acceptable contexts for light pollution definition.

Various problems have been addressed by Chapter 4 of this research. For example, a number of legal definitions under soft law and hard law remain narrow and sufficiently restrictive because of the development of harmful illuminating engineering technology, including inappropriate wavelengths, non-environmentally friendly electromagnetic spectrum as well as non- eco-efficiently visible lights. Some selected example countries, for example, the Spanish Distinct Catalan Region, accepted the need for a framework to provide a single definition of light pollution to make an attempt to tackle regional light pollution, whilst nevertheless ensuring that protection from all new elements of light pollution does not continue to be controlled by Spanish Catalonian light pollution law. This means light pollution is generally described as artificial light allowed to illuminate, or pollute, areas not intended to be lit, notwithstanding general definitions of light pollution from some significant jurisdictions do not favour all terms for light pollution precaution and prevention. So, this research argues that the legal definitions of light pollution should be flexible enough to encourage, rather than obstruct, the capability for

light pollution control to mitigate all adverse effects of artificial light in the future. This legal challenge aims at raising awareness of the importance of clear light pollution definitions and that there are some challenges when trying to apply them in practice.

In England, light practice challenges also arise, indicating the need for a thorough reform of light pollution definitions because the Government has not actually established a single definition of light pollution, set out in written statutes dealing with all elements of light pollution. Whilst the legally binding quality of exterior lights may be defined by a set of legal contexts in some selected example countries, which can be present in all lights in the right place at the right time, that light practitioners could use, one of the existing trends in English light pollution control is the rise of professional illuminating engineering bodies' lighting rules or non-legally binding frameworks that are given effect across England.

Following a set of critical analyses of Chapter 4 which clearly illustrate the strengths and weaknesses of an English non-legally binding definition, this research concludes that the English legal system lacks a single legally binding definition necessary to address all elements of light pollution. However, this may have a tactical advantage, for example to be taken into account in widely interpreting the scope of light pollutant subject matter under English law and the English Court's case decisions.

It should be noted that illuminating engineers or lighting designers may use every effort to avoid errors and to ensure that the contexts of lighting practices are complete. Because of this potential for light pollution harm, it is important that the law makers and all lighting practitioners recognise and distinguish between their concept of light pollution and their understanding of their appropriate lighting practices.

Therefore, the objective of a legal light pollution definition should raise environmental awareness of the impact of light pollution on local authorities and government. A clear understanding of the application of the legal definition of light pollution is able to assist or encourage those working in public sectors and lighting governing bodies to maximise the use of legal requirements for light pollution control. To provide safe and effective light pollution controls, the legal definition of light pollution must be brought to public

awareness or recognition in the right way in the future.

Limitations of the regulatory light pollution control include the fact that either the lack of single legal definition of light pollution or the failure to identify a number of legal contexts were critically analysed by Chapter 4. While the *Clean Neighbourhoods and Environment Act 2005* introduced artificial light as a statutory nuisance in England and the artificial light statutory nuisance currently plays a vital role in the control of intrusive light, it does not provide a single definition of light pollution specifically aimed at helping the Government, environmental and planning authorities, energy agencies, local authorities and other relevant light industry stakeholders to identify the main character and distinctiveness of light pollution. The existing provisions are not intended to draw together all aspects of light pollution and promote regulating a single legal definition of light pollution by types of inappropriate or non-environmentally friendly lighting, with different controls for outdoor lighting. In addition to specifying the main contexts of light pollution, this research recommended that the English law should be concerned with all the main types of light pollution, such as visible glare, sky glow and intrusive light. They should be clearly defined in a single definition of light pollution. A single definition of light pollution may be essential to explain modern terms of light pollution that have special meaning in light pollution legislation, for example, outdoor lights that produce blue-rich white spectral impacts as well as outdoor lights that flash, blink, or turn on and off intermittently and lights. Furthermore, English law should broadly include the significant impacts of excessive or obtrusive lights, in addition to extending legal context to showing how the aspects of light pollution will be taken account of when the sources of outdoor lights can illuminate so that it interferes with the safety of public transportation areas or it interferes with the atmospheric dark-sky environment.

There is uncertainty about how far environmental and planning law covers demands for environmentally friendly lighting practices. It clearly includes demands made following sustainable and energy efficiency uses of outdoor light but environmental problems arise in other legal contexts. It is necessary to establish a single definition of light pollution in the future. This research therefore recommends for the Government that

light pollution should be defined as *"every form of artificial light in the wrong place at the wrong time which creates sky glow, glare, nuisance, and other relevant causes of environmental degradation including some properties of artificial light which emit non-environmentally friendly or inappropriate light."* This definition of light pollution may usefully support and affect the substantive rules of existing legislation setting out the environmental and planning provisions to be observed for the purpose of protecting public and individual interests such as health, safety, energy and protection of the night environment. This definition, it was thought, allowed the traditional principles of minimising all adverse effects of light pollution on the environment, which promoted the prevention of key causes of light pollution and the precaution of all potential problems that may arise in future studies. For these reasons, it continues to be important within the new substance of the definition of light pollution that a bewildering array of legal light pollution terminology can monitor, through the environmental governing body, the condition of non-environmentally friendly light, as well as that of the environmental control system as a whole. So, the previous informal definitions of light pollution should be replaced by a new and official statutory definition of light pollution, which will put the public interest first, and increase individual confidence in the statutory artificial light nuisance. The focus on a single definition of light pollution was found to be wanting in the future light pollution control regime and a major context of light pollution terminology is to rebalance the focus, both by separating environmentally friendly elements from non-environmentally friendly elements, but also through establishing a primary metric to evaluate non-environmentally friendly lighting effects on people and the night environment due to outdoor lighting activities through classifications within each of the levels of acceptable or unacceptable environmental light.

In addition, despite having been amended from time to time, the definition of what can be considered a statutory artificial light nuisance, and the enforcement powers available to local authorities, have not kept pace with developments in statutory artificial light nuisance legislation that apply elsewhere in the England. Where a burden of proof rests

with a defendant[764], the terminology of environmental degradation based on light pollution contexts is not clear; regulatory classification of non-environmentally friendly lighting levels that may be helpful when addressing light pollution in urban brightness areas, related to the burden of proof for individual environmental interests, are not sound; and there is not a specific provision of substantive law to support sustainable lighting practices. One benefit of such a burden of proof would be to integrate more closely a single definition of light pollution with the usefulness in addressing various public concerns and for helping the public better understand individual impacts, combining their incentive effects on human health and the night environment.

10.2 Applying environmental law principles to English light pollution law

Chapter 5 has explored some of the principles of law faced by selected example jurisdictions when trying to uphold their right to a healthy dark-sky environment and their notion of relative value of the international, European and foreign alternatives concerning the right of citizens to expect the protection of the right to live in a night environment adequate to human health and well-being. The value of their lessons can encourage greater awareness of light pollution issues that affect the environment when main principles behind their rules can set out the rationale and some of the principles of environmental law and seek to offer some key points for their legislature to consider when establishing light pollution law.

Although this research can critically analyse selected substantial extracts from key sources of fundamental principles from international environmental and planning legislation providing the legislatures and policy makers with a stand-alone resource, English law nonetheless does not present an impressive range of extracts from a number of fundamental principles of environmental and planning law to help demonstrate how basic aspects of environmental and planning law from the international environmental frameworks can have an important role to play in field of reform of a number of

[764] Department of the Environment, *Guidance to District Councils on Part 7 (Statutory Nuisances) of the Clean*, available from http://www.doeni.gov.uk/guidance_on_statutory_nuisances-2.pdf accessed 06 February 2015.

potential regulatory functions for field of the light pollution control in England. To take all necessary steps to prevent and precaution light pollution by inappropriate or non-environmentally friendly lighting practices which are liable to create harms to the nocturnal environment and human health, this research recommends that English law should apply to fundamental principles of environmental law falling within the scope of outdoor light pollution control.

Firstly, sustainable development has been usually defined in Chapter 5 as development that meets the needs of present generations without compromising the ability of future generations to meet their own needs. As there is scientific evidence of previous or current harm to the healthy night environment and human well-being from widespread night environment degradation, many international environmental bodies, professional lighting bodies and governments are placing greater emphasis on assuring that environmental, social and economic development is achieved in a sustainable way. This means England should be concerned over sustainable lighting standards for getting a balance between dark-sky, ecological, illuminating engineering, and light industry stakeholders perspectives. This research strongly recommends that the Government may play a role in law reform, not only in the incorporation of sustainable features in all phases of light pollution control, but also through the introduction, regulation and enforcement of relevant disciplinary reasons.

Secondly, the following discussions in Chapter 5 give a critical evaluation of the functions, the adaptation, the application, and the implementation of the preventive and the precautionary approaches to light pollution control in international, European and foreign law. This research recommends that the Government take genuine steps to lead both prevention and precautionary actions. There are essentially a couple of legal responses to the scientific certainty that light pollution harms and uncertain occurrences surrounding the capacity of the environment to cope with the increasing demands placed upon it[765], although the key difference between the principle of prevention and the

[765] Gullett, W., 'Environmental protection and the precautionary principle: a response to scientific uncertainty in environmental management', *Environmental and Planning Law Journal*, 1997 14 (1), pp 52-69.

principle of precaution[766] is that the calculation of the risk is much more difficult in the precautionary approach because of the uncertain harms of light pollution. If the legislatures and policy makers cannot apply these approaches, light pollution control would be ineffective when there are several metrics of scientific uncertainty regarding non-environmentally friendly or inappropriate light practices.

Next, the polluter pays principle is generally defined as whoever is responsible for damage to the environment should bear the costs associated with it, but the proper approach of this principle is to ask how much a polluter would pay for the environmental remedy of their unnecessary or inappropriate lighting practices. Whilst the Ecodesign Directive (ErP) of the EU allows the Member States' Government to label for legal purposes, light industry stakeholders as polluters whose sources of light products have been confined to their own property and have not harmed others[767], the issue is linked to the question of how far light industry stakeholders will incur economic liability for the emission of non-environmentally friendly lights and inefficiently lights. This research strongly recommends that the potential polluter pays approaches of market-based instruments can more precisely target some of the more damaging forms of light pollution, for example, environmental charges, taxes, fines, banning products and deposit-refund programmes have become commonplace and understood. It addresses that the polluter should take purposes responsibilities and respective capabilities to reduce pollution when polluters are emitting inappropriate or unnecessary lights into the environment.

Finally, the principle of cooperation is important in order to disseminate and share collected light pollution information and preliminary light pollution assessment results with trans-boundary or boundary stakeholders and their local residents of urban

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[766] European Commission, *Workshop on EU Legislation: Principle of EU Environmental Law*, available from http://ec.europa.eu/environment/legal/law/pdf/principles/9%20Preventive%20and%20Precautionary%20Principles_revised.pdf accessed 31 March 2015.

[767] Cordato, R. E., *The Polluter Pays Principle: A Proper Guide for Environmental Policy*, Institute for Research on the Economics of Taxation Studies in Social Cost, Regulation, and the Environment, 2001, pp 3-4.

brightness areas or dark-sky preservation landscapes.[768] Therefore, various forms of cooperative approaches or coordinated measures to mitigate the risks that outdoor lights dangerously pose to human health, dark-sky heritage and economic activities as well as the environment, in particular, present a useful level of understanding of cooperation, how stakeholders prioritise the stage processes of light pollution control, and the specific potential consequences of complying with states enforced environmental and planning laws, including the standards of professional illuminating engineering conduct and architectural lighting practice.

10.3 Applying of the aspects of European frameworks to English light pollution law

In Chapter 7, this research noted that European light pollution may be protected in a number of different ways. However, it should be noted that there are a range of fragmented elements of the European measures for light pollution control or a number of non-harmonised rules of light pollution prevention. The gaps, fragments or loopholes of most of the existing EU legislation have not been merged into a single directive on light pollution control which applies to all main elements of European light pollution (sky glow, glare and light intrusiveness), on the entire EU region and which requires

[768] The reduction of light pollution to an acceptable level will need to ensure that quality of urban outdoor lighting is acceptable in terms of public health, affordable visibility at night and the broader night environment. A number of acceptable scales of urban exterior brightness may be designed to ascertain whether the environmentally friendly outdoor light will make an appropriate contribution to the reduction of urban light pollution to an acceptable level. While an acceptable level of outdoor brightness may be questionable, controlling an appropriate brightness of safety, security and the night environment for such light pollution control remain important legal issues. One of the legal problems in addressing degrees of non-environmentally friendly light pollution, or more properly degrees of acceptable brightness for all urban safety, security and environmentally friendly reasons, is that there have not been suitable enforceable measurements for acceptable brightness limits, and regulatory instruments to measure the acceptable brightness are necessarily complex and difficult to enforce. The question arises of whether acceptable outdoor light quality measuring devices which may be accurate and reliable for assessing relative environmental risk and outdoor light quality conditions are necessarily useful for ensuring an acceptable level. The more basically asked question and 'shall local authorities' officers and environmental authorities' staffs demonstrate that their technological device and enforceable methods used to measure outdoor light quality conditions are accurate and reliable?' and 'how many ways that people can daily monitor outdoor light pollutants in their areas?'. See National Aeronautics and Space Administration, *Amateur Guide for Air Quality Testing*, available from http://disc.sci.gsfc.nasa.gov/education-and-outreach/additional/science-focus/locus/index.shtml/amateur_guide_for_air_quality_000.shtml accessed 19 June 2014.

Member States to approach harmonisation and integration of the European light pollution control in a single European stage process whereby Member States will undertake a certain stage process, to identify light pollution problems. This research examines the legal problems presented by the Energy-related Product Directive 2009 (ErP Directive), the European Landscape Convention 2000 (Florence Convention) and the Energy Performance of Buildings Directive on sales and rental prices indicating that better energy efficiency (Directive 2010/31/EU) further in Chapter 8. It also differs from the basic elements of light pollution control, which could be harmonised by applying all necessary or appropriate lighting requirements on non-environmentally friendly outdoor lights or inefficient outdoor lights. Although the elements of light pollution have been identified by the EU Parliamentary Assembly Resolution 1776 (2010) on Noise and Light Pollution as among the preliminary areas of the common light pollution problems requiring joint actions as well as shared stage processes, EU law has not yet harmonised the substantive elements of light pollution law between member states, which means that the underlying law is essentially the same between EU Member States' regulatory light pollution requirements. This research recommends that the legislatures and policy makers can use a range of appropriate European instruments to ensure that the light industry stakeholders are complying with some existing elements of European Union legislation. To minimise intrusiveness and obtrusiveness of outdoor lights from the built environment, the Government, environmental and planning bodies, local authorities and other relevant light stakeholders should comply with all regulatory options for European lighting-related products, European planning development control as well as European green building standards**.** In the future England should adopt European regulatory measures that allow England to improve the night environment through outdoor light pollution reduction. For example, the ErP Directive should be applied to be designed in a variety ways of providing consistent EU-wide rules for improving the environmental performance of light related products (LRPs) when the reduction in astronomical or environmental dark-sky confidence produced by non eco-friendly sources of light or inefficient sources of light may affect all light industry markets in which non-environmentally friendly or inappropriate lighting practices are known to be a problem. The purposes of the LRPs may be to clarify and simplify the

current law on environmentally friendly or efficient sources of light, and to improve the law on outdoor lighting practices by filling the gaps in the English light market through a combination of ecodesign of light-related products and light pollution warning labelling. The LRPs may have an important role in promoting understanding and awareness of non-environmentally friendly or inappropriate uses of the sources of light, which underpins a wide range of knowledge for light industry consumers. The LRPs may identify key risks of non-environmentally friendly or inappropriate uses of the sources of light to be addressed in developing public light pollution awareness and provide information on how to teach people, what sources of outdoor light should contain and how they should be used to avoid inappropriate or non-environmentally light pollution in English jurisdiction.

10.4 Calling for the development of regulatory mechanisms for implementation of new illuminating engineering requirements as best lighting practices at national level

In Chapter 8 this research noted that it apparently uses comparative law skill to analyse foreign light pollution laws, consisting of the national, regional and local light pollution legislation as written. Comparative law has a key role to play in evaluating the similarities and differences of the foreign light pollution laws of different countries under critical analysis. The current written or statutory English light pollution law on outdoor lighting practices lacks a range of modern illuminating engineering requirements. For example, the urban district brightness areas and intrinsically dark-sky conservation areas have not yet covered important regulatory concentrations of public atmospheric smog or public sky glow. The written or stated lighting requirements from modern illuminating engineering techniques have not been successfully identified in order to meet the challenge of controlling all elements of non-environmentally friendly light emissions, for example, spill light, upward light as well as upward reflected light. Although the documentary research evidence presented to us shows that the statutory nuisance from artificial light under Sections 101 to 103 of the *Clean Neighbourhoods and Environment Act 2005* has a significant role in delivering dark-sky conservation enhancement opportunities as part of providing compulsory outdoor lighting

requirements in relation to intrusive light ban policies elsewhere in both national and local light nuisance frameworks, nevertheless its lack of completeness for all elements of outdoor light pollution problems make this area difficult enough for light practitioners and other relevant lighting industry stakeholders.

A growing number of comparative law studies can be found in the documentary literature, not only comparing a number of legally or non-legally binding frameworks from foreign jurisdictions, but also trying to extract comparative lessons for the modern illuminating engineering requirements from various jurisdictions where light pollution is a growing environmental problem. To avoid light pollution, some foreign light pollution legislation introduces modern illuminating engineering techniques and their legal requirements, explains how local authorities are encouraged to bring an environmentally friendly lighting perspective and new technical illuminating engineering principles for linking regulatory measures to tackle outdoor light pollution with other determinants of human health and the night environment locally through decentralising the control of outdoor light pollution to the regional, local, or municipal levels.

The statutory artificial light nuisance as a hard law in English legal system seems to follow some parts of global light pollution concerns even better than the soft law requirements from non-legally binding illuminating engineering guidelines, which non-compulsorily justify our techniques on the environmentally friendly lighting. However, similar legally binding requirements to promote sustainable illuminating engineering techniques in relation to light pollution control will bring a single regulatory regime, across all jurisdictions. If there are same global astronomical, environmental and energy problems, minimising the issues of light pollution that the Government and its environmental bodies can introduce when transposing the technical illuminating engineering requirements into national legislation, aims to address the impact of disjointed and uneven light pollution control legislation across local authorities, reducing all key elements of outdoor light pollution and facilitating urban lighting growth to the benefit of both human health and the dark-sky environment. Similarly, local authorities, whether from London, Leicester or Derby will know what they can

expect in the terminology of outdoor light pollution control, such as full cut-off outdoor light shielding, switching off outdoor lights during curfew hours and banning on outdoor use of upward light beam displays, so enhancing the response of local authorities in England to control all key elements of outdoor light pollution. So, this research recommends that the regulatory illuminating engineering requirements should be compulsorily used to control the inappropriate levels and non-ecologically friendly direction of harmful light pollution in England, by use of dominant illuminating engineering standards, through clarifying comparative light pollution law and process with regard to recognising advantages from regulatory illuminating engineering requirements received in various jurisdictions as mentioned in Chapter 8.

10.5 Specify the environmental zones for outdoor lighting control

This research recommends that the English legal frameworks would be improved if many of the provisions could be brought together in a single light pollution law that so far as possible subjected all effects of light pollution on human health to the same requirements as well as practices. It introduces the new ideas of lighting control regime in that the aim of legal regime should be to increase the health knowledge and legal measures of all public or private stakeholders in light pollution control when excessive or intrusive lights still dramatically affect human health. For example, the laws should apply a preliminary light pollution assessment of urban brightness areas[769] to identify planning areas where risks of light pollution exist and the law should establish dark sky maps for such conservative dark landscapes and urban brightness areas where health risks of light pollution exist. Important questions also arise as to the link between basic

[769] Introducing atmospheric sky glow information based on outdoor light pollutants would have precautionary or preventive information resource, and raise some critical questions about what should happen to the daily brightness smog forecast. The best option was thought to be improving and simplifying levels of atmospheric light pollution are expected to reduce to an acceptable level of outdoor light, due to outdoor light emission in various geographic areas. The daily dark-sky quality index may be designed to show complex dark-sky quality information on an easy understanding measurements for communicating the levels of outdoor brightness expected. See Department for Environment, Food and Rural Affaires, *What do the forecasts mean?*, available from http://uk-air.defra.gov.uk/forecasting/what-forecasts-mean accessed 19 June 2014. and see also Graf, T. and Mikulasek, Z., *A Simple Scale to Determine the Level of Light Pollution*, available from http://www.darksky.ie/a-simple-scale-to-determine-the-level-of-light-pollution/ accessed 19 June 2014.

principles of environmental and planning law and new legal techniques for dealing with risks to human health through light pollution control.

Urban expansion generally leads to higher levels of atmospheric or smog light pollution in urban areas. The causes of growth of outdoor light installations and design in urban areas and the causes that are responsible for the undesirable use of some kinds of illuminating engineering technologies or architectural lighting techniques are also essentially important for the spread of non-environmentally friendly or inappropriate outdoor light pollution at night. The effects of them, whether non-environmental or non-sustainable, are also necessary to be controlled by the lighting zoning requirements. Zoning can apply in light pollution control by classifying intrinsically dark landscapes and district brightness areas. If this research wishes to meet environmental challenges, the urban lighting developments should be zoned, where practical, to reduce energy consumption and create night environment protection.

With the proliferation of regulatory planning regimes in various jurisdictions as mentioned in Chapter 8, there are the aims to regulate certain requirements for exterior lighting installations in order to promote human health, sustainable energy consumption, safety, and the nocturnal ecosystem in both urban and rural areas and to form measurable level of outdoor lighting to improve the relevance of environmental risk assessment through measurable metrics of upward light ratio of the installation (ULU), vertical illuminance in *Lux*, light intensity in *Cd*, and luminance in *Cd/m2*.

To demonstrate desirable planning development steps of light pollution control in the future, legislators and policy decision-makers in England should expect to have to reconsider their legal analyses and policy decisions as a new lighting development plan comes to make arrangements for implementing necessary stage processes that address the significance of the risks for exterior lighting control within urban development plans. This means that some of the linkages between opportunities and planning authority functions can provide a number of ways in which to join up necessary local dark-sky protection steps in the future, including the preliminary light pollution assessment of the environmental zoning for exterior lighting control as well as the dark-

sky light pollution mapping for such intrinsically dark landscapes).[770] For example, a site-specific urban brightness assessment must demonstrate that the outdoor light installations and design in urban areas will be safe and efficient for low impact on the night environment, without increasing harmful elements of outdoor light pollution elsewhere, and, where possible, will reduce the environmental risk overall.

10.6 Reviewing the exemptions from statutory artificial light nuisance under Sections 101 to 103 of the Clean Neighbourhoods and Environment Act 2005

Whilst the exemption premises under Sections 101 to 103 of the *Clean Neighbourhoods and Environment Act 2005* have a significant role in delivering safety and security, designing in safety and security exemptions to the intrusiveness of light in accordance with statutory artificial light nuisance requirements raises specific concerns about its potential to pollute the key elements of light pollution. As mentioned in previous Chapters, the *Act 2005* can ensure that all matters involving the element of intrusive light pollution relating to the outdoor lighting both locally and nationally have been tackled, controlled and prevented to effectively balance the response to risks[771] for

[770] Official authorities should have their light pollution maps measured at least once every few years. An identification of geographical light pollution areas called a map of outdoor brightness and darkness sites at night can help show whether English people are at risk for their health by looking at outdoor brightness that carry key elements of light pollution (i.e., local authorities may provide accessible information on how local dark-sky quality is monitored in their district brightness areas, and where the measurements of urban brightness are located. These may involve a Geographic Information System (GSI) map showing all urban sky glow sites at night). While a number of geographical differences in light pollution impacts develop environmental awareness of the potential dangers of excessive or obtrusive light at night, there are numerous illuminating engineering techniques and astronomical dark-sky sources to assist official authorities in identifying and evaluating outdoor lighting practices. The relationship among variables indicating socioeconomic character, light energy consumption, urban development and land use with the density for light polluting facilities should be investigated by official authorities. Outdoor light pollution control, in setting dark-sky quality control areas and drawing up policies for achievement of environmental objectives, must take into account geographical issues of planning development, outdoor light facilities, economic development, public health and social inclusion. See Day, R. J., *Perceptions of Air Pollution and Health in Social and Geographical Contexts*, PhD Thesis, University of London, 2004, p 16. and see also Chalkias, C., Petrakis, M., Psiloglou, B. and Lianou, M., 'Modelling of light pollution in suburban areas using remotely sensed imagery and GIS', 2006 (79) *Journal of Environmental Management*, available from http://www.csun.edu/~dlb10399/Docs/Geog406_Spring10/Readings/LightPollution_Chalkias_2006.pdf accessed 19 June 2014.

[771] Non-environmentally friendly lighting assets contribute to managing risks to environmental, social and

neighbour health problems due to prejudice-related results of light pollution, within statutory law. However, light pollution from exceptions to emit all key elements of light pollution comes from emission of safety and security light premises. Consequently, where safety and security premises within exemptions to environmental permits are illuminated the source of excessive or obtrusive light (e.g. airports, railway, tramway, bus premises and any associated facilities, public service vehicle operating centres, goods vehicle operating centres and prisons-including Youth Offenders Institutes) may be directed upon any part of a neighbouring residence or into any area zoned for residential use. Upward-beamed illumination from exemption premises is able to reflect off atmospheric particles and fine water droplets in the public atmosphere to cause public atmospheric smog that can be sky glow although exemption premises play an important role in the delivery of public safety and security across several key areas of English public service.[772]

This research recommends that the Government and light industry stakeholders should achieve a balance between the environmental protection and the need for safety and security lighting premises. Moreover, legislators and policy makers should adopt statutory regulations with respect to environmentally friendly lighting technology for all public service premises that are more innovative than Sections 101 to 103 of the *Clean Neighbourhoods and Environment Act 2005*. If many exemption premises under the *Act*

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economic activity, helping to regulate light pollution risks, regulating the growth of outdoor light areas, and maintaining the other sources of outdoor lights. The local authorities may evaluate risks to public health and to ecosystems associated with all public service sites as part of the stage process determining whether they should be listed. See Turnley, J. S., *Social, Cultural, Economic Impact Assessments: A Literature Review*, GALISTEO Consulting Group Inc., 2002, p 1.

[772] It may be known that, when levels of atmospheric light pollutants rise at night, people suffering from human health conditions, and people with light–dark cycle mechanism conditions, are at increased risk of becoming an imbalance of 24-hour cycle of biological processes. Only a minority of those who suffer from these conditions are likely to be affected and it is not possible to predict in advance who will be affected. Some people are aware that atmospheric light pollution affects their health: adults and children with circadian rhythm disorders are 24-hour cycle of biological disruptions may notice that they need to increase their balance of 24-hour cycle of biological processes throughout the night when levels of atmospheric sky glow are higher than acceptable illuminating levels. See Department for Environment, Food and Rural Affaires, *Guide to UK Air Pollution Information Resources*, Department for Environment, Food & Rural Affaires, 2013, p 8. and see also Ding, J., *Impact of HARMONIE high-resolution meteorological forecasts on the air quality simulations of LOTOS-EUROS*, Royal Netherlands Meteorological Institute, 2013, p 5.

2005 employ excessive or obtrusive lights shining upwards with much of the light missing its safety and security target and instead causing atmospheric smog in the public atmosphere or sky, the future legislation should provide more regulatory illuminating engineering solutions to light industry stakeholders and make energy efficiency a more important way of working out whether to give a range of statutory exemption conditions for particular safe and security light operations by using energy-efficient technologies and environmentally friendly lighting practices in the future. Finding a better balance between social, environmental, economic, security and safety objectives can help ensure future generations the safety or security opportunities enjoyed by people and public service stakeholders when light still generated at various kinds of safety or security premises is exempt from public service operating premises.

In other words, exemption premises create significant elements of light pollution and could cause loss of the night environment if used without illuminating engineering protection. Some of the available illuminating engineering techniques for control of non-environmentally friendly light can reduce light pollution from exemption premises while at the same time making them more effective. Nevertheless, urban development would have predictable expansion of urban lighting areas, and raise some difficult questions about what should happen to foreseeable light pollution. An option was thought to be improving and simplifying the main way of adjusting measured outdoor illumination to levels which take into account public facility effectiveness and an energy efficiency lighting response, particularly the adjustment of balancing between the purposive uses of exemption premises and the protection of human health and the night environment. This means that specific regulatory metrics need to be narrow and standardised. When facing two options between excessive brightness of the public facilities on the one hand and environmentally friendly lighting on the other, the need for a more measurable approach is particularly apparent in the light pollution context. Simple modifications to light directions and brightness of the exemption premises reduce the unacceptable level to a more acceptable level.

10.7 Setting hard law and soft law interactions in light pollution control regulation

Influences of soft law or non-legally binding law can be found in many legal systems as mentioned in Chapter 8. Our review of the comparative law has highlighted the recent evidence of such influence of soft law on light pollution legislation in different countries. This research critically examined the influence of soft law within the professional astronomical bodies as well as illuminating engineering bodies on standard-setting in light pollution control frameworks. Central or local governments from several jurisdictions (i.e. U.S., France and Canada) have already accepted all the key harmonised aspects of the soft law and intend to implement the soft law standards in their national and local jurisdictions, with the aim of reducing all key elements of light pollution and combating non-environmentally friendly or inefficient outdoor lighting practices. Although English law includes a key element of measures for the reduction of light intrusiveness, either through statutory artificial light nuisance established or by newly updated soft law instruments as non-legally binding instruments (i.e. the *Institution of Lighting Engineers' Guidance Notes for the Reduction of Obtrusive Light* and the *British Astronomical Association's Campaign for Dark Skies' Lighting Guidance*), it has not yet represented a wider range of non-legally binding mechanisms through the offers for alternative choices of soft law adoption, relevant public concerns of local light pollution problems. For example, soft law offers a modern green building requirement associated with light pollution reduction by relying upon green building targets regarding the minimisation of inefficient outdoor light fixtures or non-environmentally friendly light design. So, the local authorities can adopt a soft law mechanism to mitigate risks of light pollution through the implementation of a construction plan. It could be covered by bans on inefficient outdoor light fixtures and which could be covered by exemptions for safety and security reasons. Where emission of outdoor light in the wrong place at the wrong time is an environmental problem and a major concern for exterior light practitioners in England, this research strongly recommends the light industry stakeholders should consider the introduction of soft law mechanisms to encourage the use of sustainable lighting practices, limit inappropriate lighting or reduce the number of non-environmentally friendly installations or non-

ecologically friendly lighting design.

10.8 Setting all certain legal metrics, enforceable measurements and regulatory degrees

As referred to in Chapter 8, the indicators of light pollution, (i.e., legal metrics, enforceable measurements and regulatory degrees) have been the significant influence on the aim of uniformity of light pollution control criteria. Measurable SI metrics have not been successfully adopted by English law as a legally binding indicator for all of the adverse impacts on human health and the night environment (for example, annoyance, disturbance, intrusiveness, and obtrusiveness). While light intrusiveness can be capable of being a statutory artificial light nuisance, in which case outdoor light pollutants may be the subject of proceedings in tort by individuals aggrieved by the degree of English statutory nuisance as mentioned in Chapter 8, the English statutory law under the *Clean Neighbourhoods and Environment Act 2005* does not set a measurable scale to calibrate all acceptable or unacceptable direction and brightness of outdoor light. Therefore, the scale of outdoor lighting in England and the associated risks should be identified to approach the best stage process of dealing with light pollution measurements. They should also carry out mapping and modelling of local brightness areas and uses this information to prepare enforceable SI Unit measurements of those areas at risk. For example, a preliminary light pollution assessment may be derived from mapping and modelling of intrinsically dark landscapes and district brightness areas, and light pollution data collected from measurable indicators of the level of sky glow, light intrusiveness, source of intensity and building illuminance at night. A preliminary light pollution assessment and urban district brightness zoning for environmental outdoor lighting impact assessment through enforceable SI Unit measurements could explain the cycle of urban planning to control harmful light pollution risk in England. This may involve a list of the conservation dark-sky landscapes and urban district brightness areas that may be identified by lead local environmental and planning authorities when they need to give insights into quantitative levels of acceptable or non-environmentally friendly light and links to urban planning development. The identification of the level of upward light ratio of the installation (flux), vertical illuminance (lux), light intensity

(Cd), luminance (Cd/m2) and curfew illuminance (lux) which identifies the degree of outdoor light pollution as mentioned in Chapter 2, 4 and 8 can show a number of outdoor lighting energy consumption areas, particularly in outdoor areas with a high population density and a high level of concentration of outdoor lighting activities.

In addition, the regulatory metrics of the International System of Units (SI) for outdoor light pollution emittance measurement can be normal instruments for tracking environmental risks, supporting environmental or dark-sky awareness and informing environmental or astronomical information. However, more normally, environmental, social and economic outdoor lighting-series data on outdoor lighting energy consumption still needs to be effectively developed. A fairer balance between the needs of outdoor light users and society interest, public light premise users and economic growth. It should be done to monitor sustainable balance between all lighting parties and to develop a range of appropriate enforceable indicators that better reflect the light pollution risks and sustainable benefits of environmentally friendly lighting in urban environments compared with non-environmentally friendly lighting. The regulatory metrics of the SI Units for outdoor light pollution emittance measurement should raise a range of important economic cost-effective data, environmental risk indicators, and social issues for outdoor light practitioners endeavouring to predict levels of how to stay safe in rural dark-sky landscapes and urban district brightness areas.[773] They may be designed in connection with other economic and social indicators and in particular with indicators on sustainable quality of English people's lives in the future.

[773] Light pollution meteorology will have an important, theoretical application in the district brightness areas of environmentally friendly lighting control and management of dark-sky quality. Its importance need to be realised when the increasingly excessive use of lights for urban outdoor lighting and industrial power led to episodes of extreme atmospheric sky glow during normal 24-hour synchronisation of human circadian rhythms as mentioned in Chapter 2. However, there is an ordinary willingness to question existing meteorological practices and to consider, without prejudice, a wide range of certain light pollution forecasts. There are also a number of theoretical reasons why relevant stakeholders should monitor dark-sky quality and environmentally friendly lighting conditions. See National Weather Service Forecast Office, *Careers in Meteorology Job Information for those interested in Meteorology*, National Weather Service Forecast Office, 2006, p 2.

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